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ASIA BEYOND THE BORDER:  
PHYSICAL GEOGRAPHY

- Central and Northeastern Asia

By D. L. Armand,  
et al

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ASIA BEYOND THE BORDER:  
PHYSICAL GEOGRAPHY

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CENTRAL ASIA  
GENERAL SURVEY

Geographic Position

Central Asia extends for almost 2,500 kilometers from north to south. Its northernmost coordinates are  $52^{\circ}$  and the southern coordinates are  $28^{\circ}$  N. This is vividly reflected in a landscape that changes from north to south. The distance of the middle areas of Central Asia from oceans and seas, and especially the fact that they are surrounded almost on all sides by an imposing circle of great mountains along with a high average hypsometric level of the country, have all basically brought about the severe natural environment and the incomparable peculiarities of the physical-geographic conditions prevalent in this part of the world. The barren nature of the continental deserts, the grandiose scope of the mountain ranges and of the high upland areas along with the low depressions, many internal non-draining (enclosed) basins, a highly continental type of climate with all of its peculiarities, all achieve their most outstanding expression in Central Asia.

All of the above indicates that great interest has in the past, and is at the present time, represented by the geography of Central Asia.

Dimensions and Borders

Different connotations have been attributed at various times to the concept of "Central Asia" in geographical literature. An outstanding geographer and encyclopedist of the past century, Alexander Humboldt, changed his definition of Central Asia by at first excluding Tibet, and then considering that "Central Asia actually stretches from southern Altai to the northern slopes of the Himalayas."

A well known explorer, Ferdinand Richthofen, delineated Central Asia from the rest of that continent. According to his definition, land areas not draining into the ocean form the Central Asian massif. "Central Asia is an interconnected continental area of ancient non-draining water basins: a country where the prolonged existence of the latter has brought about the full development of peculiar phenomena stipulated by the lack of drainage. In general terms, this area extends from the Tibetan highlands in the south to the Altai in the north, from the Pamir watershed in the west to the great rivers of China and the Khingan mountain range in the east."\* (\*Note: Richthofen, "China", Berlin, 1887. The cited quotation was translated by V. A. Obruchev.)

According to Richthofen the southern and western parts of the Mongolian People's Republic, almost all of

Dzungaria, Kashgaria, and northern Tibet must apparently be considered as Central Asia. Despite the fact that our Middle Asia or, as it was formerly referred to, "Russian Turkestan", also does not drain into the ocean, but, according to Richthofen, these are peripheral areas of the interior of Asia, as the cited areas have ceased draining into the ocean in recent geological periods and drain into the Aral and Caspian seas. Richthofen's definition of Central Asia was inconsistent. A number of areas, termed "transitory", draining into the ocean, were also included into Central Asia on the basis of the fact that they have only recently started draining into the ocean. Selenge, the upper portions of Onon and Kerulen, the Black Irtysh basin, and the upper portion of the Hwang Ho basin, among others, fall into this category.

With the present degree of knowledge it is impossible to accept Richthofen's reasoning, as there is a greater basis to suppose that during the Quarternary period the non-draining region of Central Asia expanded; in any case this is undoubtedly what occurred in the north of Dzungaria and the southern part of the Mongolian People's Republic, certain regions in the interior of Mongolia and in some other areas.

The unsatisfactory nature and conditionality of Richthofen's definition was eventually pointed out by our great explorer of Middle Asia, I. V. Mushketov, who proposed that the term "Central Asia" be left with the interpretation given to it by Richthofen, but at the same time considered it necessary to consolidate the large mountain and desert regions in the interior of the Asian continent into a single region of Interior Asia, which, in Mushketov's opinion, should include Central Asia (as defined by Richthofen), as well as Russian Turkestan, a portion of Iran and Asia Minor.

Foreign literature frequently includes the Aral basin into Central Asia, which is referred to by us as "Middle Asia", and in a physical geographic sense includes the southeastern part of Kazakhstan (Semirech'ye or Dzhetysu). Tibet is sometimes pointed out in literature as a particularly outstanding physical-geographic region.

The location of the physical-geographic borders of Central Asia are influenced by the political borders as well. Strictly speaking, basins at the upper course of the Selenge, Onon and Kerulen rivers must be regarded as the southern extension of the East Siberian uplands and the Trans Baikal forest steppe, but the national border of the Soviet Union, together with the Siberian border, necessitates the inclusion of the enumerated regions into Central Asia.

V. A. Obruchev has recently given a simple definition of Central Asia which "... is bordered on the west and north by the border of the USSR, on the east by the Great Khingan watershed, on the south by the Great Wall of China up to the city of Lanchow, and from there on by foothills of the Kun-lun range". [See Note] Therefore Kunlun, like Tibet, is not included into Central Asia, according to V. A. Obruchev.

[Note] The contribution of Russian Scientists to the study of Central Asia. Trudy II Vsesoyuznogo Geograficheskogo S"ezda (Works of the II All-Union Geographic Congress), page 92, Vol 1, Moscow, 1948; or Izbrannyye Raboty po Geografii Azii (Selected Works on the Geography of Asia), Vol 1, page 230.

According to the above there is still no commonly accepted definition of Central Asia, especially in view of the fact that such a definition could not remain static but must change with the historic circumstances [See Note] along with the degree of knowledge of the region. Without transgressing the administrative borders of China and of the Mongolian People's Republic, which politically contain all of Central Asia, we include the entire territory of the Mongolian People's Republic (Outer Mongolia), the provinces of China bordering it, the Koko-nor and Nan Shan regions as well as the northwestern portion of Kansu. All of these extensive regions form the northern part of Central Asia or, more specifically, Central Asia. The southern portion of Central Asia is formed by Tibet, in a broad physical-geographic sense and not in a narrow administrative context of this geographical name, or as it is referred to by the Chinese authors, Hsik'ang-Tibet uplands.

[Note] The change in geographical borders with time is a common phenomenon. This is substantiated by the denotation "Siberia", which formerly included the Urals and the Far East, which are now excluded in place of Tuva, which was previously considered as a part of Central Asia. The meaning of the term "Mongolia", which in the last century was considered to include Tsinhai and a portion of Hsik'ang Kansu, has also changed. The term Turkestan, and especially "Eastern Turkestan" has virtually vanished from literature, a term which was frequently used in geographical literature during the 14th Century. There are many such examples.

This delineation of Central Asia borders on India, Afghanistan and the Soviet Union along an extensive border-line from the uplands of the Pamir river Murgab (the right tributary of the Pyandzha) up to the Torey lakes and the area beyond Baikal lake and the northern tip of the Great Khingan mountain range. The southeastern part of Central Asia almost throughout borders on the various provinces of China, with the exclusion of the western part of the Kansu

province, which, as indicated above, is the only part included in Central Asia. Interior Mongolia bordered by the mountains east of the Great Khingan range are already outside Central Asia.

Western Hsik'ang-Tibet uplands in a physical-geographic sense include the continuation of Tibet, even though that area has a changing landscape from the forbidding Tibetan landscape to the gentle hospitable landscape of South China.

The eastern borders of Central Asia pass along the massive Szechwan and Great Khingan ridges, which descend in steps to the lowlands of eastern and northeastern China.

The portion of Central Asia located within the borders defined above includes 6.3 million square kilometers, i.e. approximately 1/7 of the entire Asiatic continent and 2/3 the area of Europe.

#### Population

The population of Central Asia consists of different races. The ethnological composition of this region is most variegated. By grouping all the strains into principal ethnic groups it is possible to classify them as follows: 1) Chinese, 2) Turkic, 3) Mongol, 4) Tibetan. The Turkic group inhabits the western half of Central Asia. This group includes the Uighurs, or as they were formerly called, Kashgarlyks, who inhabit the Kashgaria region, and the Taranch group which live in Dzungaria, principally in the Ili valley: these are agricultural people of Sinkiang, inhabiting the oases and cities of Eastern T'ien-shan in southern Kashgaria. The Kirgizians are also of the Turkic strain and populate the East Pamir, Karakoram -- T'ien-Shan mountains. The Kasakhs occupy extensive pasture lands of the Dzungarian plains and the southern slopes of the Mongolian Altai mountains at the source of the Irtysh as well as the western corner of the Mongolian People's Republic, i.e. the Mongolian Altai at the source of the Kobdo river and of its tributaries. The Kazhaks and Kirghiz differ little ethnically and linguistically from their tribesmen living within the boundaries of the Soviet Central Asian Republics. The Mongolian Altai is populated by the nomad cattle raising peoples -- the Altai Uriangi, who are ethnically close to the Tuvints of the Upper Yenisei. In Mongolia the Tuvints live in the vicinity of Lake Hobso-gol.

Extensive uplands and deserts of Central Asia are inhabited by Mongol people. They are cattle breeders with centuries of experience in nomad cattle breeding; they breed five varieties of cattle: sheep, goats, large horned cattle (including yaks), horses and camels.

The Mongolian People's Republic is mainly populated by a large group of Mongol people -- the Khalkha, who have preserved the original language and ways of life of the ancient Mongols. The northern part of the MNR (Mongol'skaya Narodnaya Respublika -- Mongolian People's Republic) is inhabited by the Buriat tribes, the steppes west of Khingan are occupied by the nomad Berkut tribes, and western Mongolia is inhabited by Mongol tribes known as the Oyrat, or western Mongols, which include: the Dyurbet, Bayat, Torgout, Dzachachin, Olot, Mingat and others. They combine cattle breeding with wet farming, while basically remaining a nomad cattle breeding people. Their language and culture have been strongly affected by the Turkic influence. The Mongols live a nomad life in Dzungaria and in Inner Mongolia. In Dzungaria they are represented by the Torgout, who also live in the Autonomous Region of Inner Mongolia, as well as by the Bargut, Hoshut, Chahar and others. The Mongols occupying the southern parts of Inner Mongolia have been profoundly influenced by the Chinese. This influence is reflected in both their language, economy and modus vivendi. One not infrequently encounters a Mongol in Inner Mongolia, especially in the Great Khingan whose sole occupation is the cultivation of land. Mongol cattle breeders also inhabit the plains and mountains of Nan-Shan (the Koko-Nor and Tsaidam Mongols who call themselves "Tsagan Mongols", i.e. white Mongols); it is also possible to encounter them in the northern part of the Hsikang-Tibet uplands.

The Tibetans are essentially the people of Tibet, but they also inhabit the Nan Shan mountains and Koko-Nör where they were described by Przhevalskiy as Tanguts ("Mongolia and the Country of the Tanguts"). Farming in Tibet is basically cattle breeding in the north and agriculture in the south; it is thus possible to distinguish between the nomad and settled Tibetans. The latter live in dwellings constructed of stone and wood.

The Chinese are settled in almost every province and country of Central Asia. They formerly populated border territories of the Chinese Empire as colonists, government officials and traders. In Sinkiang they are mainly situated in the cities and oases. In the Mongolian People's Republic the Chinese population is essentially engaged in agriculture, various handicrafts and petty trading activities. The majority of the Chinese in Central Asia are settled in Inner Mongolia and Kansu where they are principally engaged in agriculture.

In the past, during the time of the Imperial and Kuomintang China, Singhai and Inner Mongolia were considered as peripheral colonial possessions, and the people populating these areas were considered as a subservient

lower class. At the present time, however, due to the victory of the revolutionary democratic order and the formation of the Chinese People's Republic, all the minority peoples of China have received equal rights: Uighur, Mongol, Tibetan, Kazakh, and Dunghan.

The Dunghan have previously been regarded as Mohammedan Chinese who have experienced strong anthropological and ethnological influence by the Turkic peoples, who subjected them to religious and cultural pressure, converting them to Islam. According to another theory, the Dunghan are an indigenous Turkic (Uighur) people, who have come to strongly resemble the Chinese and who at the present time speak the Chinese language.

As a result of new anthropological and ethnological studies it has been determined that the Dunghan group is basically composed of emigrants from North China; their racial origin, however, is complicated by Malayan and European strains. The Dunghan differ little from the Chinese in their mode of life and methods of farming. The basic occupation of the Dunghan is agriculture, trading and various handicrafts. They inhabit the Kansu province, and there is a considerable number of them in Sinkiang. They have also settled within the boundaries of the Soviet Union, at Semirech'ye (Kazakh and Kirgiz SSR). The presence of Tadzhiks, Hindus, Gypsies and small South Tibetan tribes in the southern part of Central Asia must also be noted. These are still relatively unknown and their ethnic classification must therefore be delayed.

At the present time the peoples of all the regions of Central Asia are proceeding along the path of building socialism, having completely freed themselves of the bondage of the imperialist powers. The economically and culturally backward peoples of Central Asia were ignorant of industry. Their agricultural activity primarily consisted of nomad cattle breeding with scattered crop cultivation -- this was widespread and of low productivity. Feudal relationships were dominant in Central Asia, and were complicated by the strong influence of the Mohammedan and Buddhist churches.

The Great October Socialist Revolution brought about an upsurge in the revolutionary movement in the countries of the Far East. Outer Mongolia was the first country to sever its ties with feudalism and to undertake a course of socialist development. It is at the present time known as the Mongolian People's Republic, the first democratic country in the east beyond the border. What was a backward cattle raising country now has its own industry, principally mining, light and food industries, in addition to highways and railways, an air fleet, all modern forms of communication, a widespread network of

schools from elementary to the higher educational institutions, together with a well established system of public health. During the revolutionary reforms the number of cattle doubled and the area under crops increased. Economic and cultural progress in the Mongolian People's Republic is being made by the masses who are building their new state.

The Chinese People's Republic is executing a grandiose plan of construction over a large area from the shores of the Pacific Ocean in the east to the Soviet border in the west. Its Central Asiatic provinces are not left by the wayside. The press frequently carries reports of progress made in the building of the new life in Tibet, Sinkiang, and Inner Mongolia. Automobile highways, which are 5,000 meters above sea level in places, have been built to Lhasa, the capital of autonomous Tibet. The first trains have arrived at Lanchow from T'ienshui along the new 505 kilometer long railroad. This railroad is being extended farther west from Lanchow towards Sinkiang and Alma-Ata and will be the first railroad to cross the breadth of Central Asia. Another railroad has already traversed it along the meridian from Ulan Bator towards the southeast, crossing all of the Gobi Desert from north to south. A railroad is being built from Chengtu, which is already connected by rail with Chuntsin, to T'iangshui over the Tsin Ling range, under mountain conditions which considerably complicate construction. The magazine "New China", 1952 (No 23, page 38) reports:

"A modern iron and steel smelting plant was constructed in the remote province of Sinkiang, in addition to a cotton mill, cement factory, electric plant and a machine building plant, and a new coal mine began operating. The building of industrial enterprises continues."

In Sinkiang, where agriculture is possible only with artificial irrigation, only 18% of all the arable land was used, amounting to 6.5 million hectares. A proposed plan which is already in the course of fulfillment, stipulates the irrigation of 330,000 hectares of new lands. A large new water reservoir is in the process of construction on the Urumchi river. Industry in Sinkiang is also expanding: the mining of non-ferrous metals, oil, coal, the food, and the light, mainly textile, industries.

Special attention is being devoted to the development of cotton industry, an increased production of oil, and the creation of electric power plants.

The Inner Mongolian Autonomous Region is the first national autonomous region in the New China. The economy of this region is basically agricultural. The number of cattle is growing from year to year, the cultivation of land is expanding, timber production, which is based on

the richest forests of the Great Khingan, is expanding. The mining industry is also developing in the Autonomous Region -- the mining of gold and coal; this is in addition to the light industries -- leather tanning, wood processing, and the food industry -- canning, alcohol and others. New electric power plants and iron manufacturing enterprises have been constructed.

Tibet is a very extensive upland region of the Chinese People's Republic; at the present time the new life is being experienced here as well. Passenger aircraft fly over the highest upland region in the world, that of Tibet. The first hospital, library and schools have been put into operation in Lhasa. There has been a sharp increase in trade relations between the Tibetan population with the remainder of China, which receive wool and leather from Tibet. Tibet is rich in useful minerals, and even though agriculture is limited due to the severe conditions imposed by the high mountains and plateaus, the mining of precious metals, various ores and other minerals has extensive potential. Cattle breeding will expand in Tibet, especially the raising of sheep, yak, and the breeding of goats. Tibetan goats yield excellent down which is used for the manufacture of the world renowned Cashmere shawls. The goats are principally bred in the southwestern region of Tibet.

#### The Ancient Cultures of Central Asia

Throughout many centuries Central Asia was an area where great masses of nomad peoples originated and, in their conquests, reached the banks of Dunai and the shores of the Mediterranean. Various Turkic tribes ranged from this area and from the neighboring areas of Turkestan and Siberia during the early Middle Ages. Here the mighty state of Genghis Khan and his followers, one of the greatest despotic powers known in history, was formed. It strongly affected the fate of almost all of Asia, as well as that of Russia, retarding its development for several centuries.

Numerous archeological discoveries verify the existence of a number of ancient cultures during the Turkic and Mongol epochs. The deciphering of certain inscriptions and a discovery of the ruins of Karakoram, the ancient capital of Mongolia, in Hsiangai on the banks of the Orkhon river yielded a wealth of material for the study of the language and culture of the ancient people of Central Asia. The famous excavations by P. K. Kozlov of the dead city of Hara-Hoto in Central Gobi provided an idea of the highly developed culture of the Hsi-Ya people. Some 2,000 books in seven different languages, 300 samples of Buddhist and other drawings, sculpture and

other proof of the high material and spiritual level of the Central Asiatic people during the Middle Ages were found at Hara-Hoto. The Hsi-Ya government disintegrated under an attack of the Mongol armies, the city was demolished, and the irrigation system that provided it with water from Edzin-Gol was destroyed.

Chinese culture had a great influence on the economy and culture of the Central Asiatic people: the Tibetans, Mongols, Uighurs, and Dunghans. Such influence was variegated and was primarily felt in agriculture, as Chinese agriculture is one of the oldest and most intensively practiced. It was also reflected in their folk crafts, in art, in their way of life, where the Chinese folk customs are fantastically interwoven with the local customs which retreat deeply into the prehistoric past of the Central Asiatic nomad tribes. It is natural that the influence of Chinese culture is most clearly evident in the eastern regions of Central Asia where the people have come into contact with China and the Chinese earlier and to a greater degree. It is less perceptible in the remote western regions such as the Mongolian People's Republic, Izwafaria and western Tibet.

#### Geographic Names

In studying the map of Central Asia the predominance of Chinese, Mongol, Turkic and Tibetan geographic names is rather striking. Mongol names are the most widespread. They are found in regions where there are no Mongols or where they comprise only a small percentage of the population. This substantiates the fact that Central Asia was the home of Tibetan, Mongol and numerous Turkic peoples. Apparently these groups are autochthonous. Also the ancient Mongoloid tribes originated in Central Asia, particularly at the upper course of the Wang Ho river, the Yangtze river and Lake Koko-Nor, where they forced the Tibetans to migrate south.

"All of the most ancient geographic names in the Koko-Nor area and at the upper course of the Yellow river, which are given in 'Wei-Shu' (a composition written at the beginning of the second half of the IV century), and other Chinese historical writings of the Pre-Dan epoch, are either Tibetan or Mongolian, or sound Mongolian," writes G. E. Grumm-Grzhimailo, a well known authority on the history of Central Asia.

Let us cite several examples of this widespread permeation of the Mongolian geographic names and their stability. In Sinkiang, Tibet and even the Himalayas it is possible to frequently encounter Mongolian geographic names. The region of Lake Koko-Nor (Blue Lake in Mongolian) contains numerous Mongolian names: Tumurtu-Ula

(Iron Mountains), Hara-Nur (Black Lake), Tsaidam (Saline Soil), Hara-Usu (Black Water), Dzharan-Nur (Sixty Lakes). The Hwang Ho at its upper course is known by a Mongolian name of Altan-Gol, which means Golden River; it flows through Odon-Tala, i.e. the Star Plain. The upper course of the Salween river is called Hara-Usu, meaning Black Water (river). Directly adjacent to Lhasa there is a lake called Tengri-Nur, i.e. Heavenly Lake. Such examples are most numerous.

On the other hand the ancient Turkic names are also evident in the topography and are noted far to the east of Manchuria. In Manchuria, for instance, there is a lake Baidarig, a name which is not understood by the Mongols. Translated from Turkic this name means "a rich broad valley". It is easy to remember the Baydar valley in the Crimea. The name of a well known lake Hobso-gol (Kosogol), after careful examination turns out to be a complicated Turkic name: Kop-su-gol, i.e. High Water Lake. These are not exceptional cases. The number of Turkic names, naturally, increases in Dzungaria and particularly in Kashgaria (Yarkand, Aksu, Karashar, and many others). Pre-Mongolian, pre-Turkic, and especially Persian geographical place names are encountered in Central Asia. Ancient inhabitants of Eastern Turkestan were Sogdiy, a people who spoke one of the Persian languages. Hence, there is found such place names as Khotan, Kashgar, Lyangar, Lob and others.

The Chinese geographical names in Central Asia are comparatively new. They appeared on official Chinese geographic maps, including such names as: Yangtze and Hwang Ho which are unknown by these names at their upper courses, Tsinghai instead of the Mongol name Kok Nor, both meaning "Blue Sea or Lake", and others. Chinese endings are frequently preceded by prefixes in other languages. For example, the place name "Sulehe" in which the suffix is the Chinese word "he", meaning river, is a recent addition.

The following table gives the most important geographical common nouns, frequently forming a part of proper geographical names. (See next page)

A Translation Table of the  
Most Commonly Encountered Geographical Terms

Russian	Chinese	Mongolian	Turkic	Tibetan
Passage, pass	Shanyalu kuan, k'tou	Daba, hutul	Art, bel' ashu	La
Mountain	Shan	Ula	Tag, tau	Ri, tsze
Ridge	Lin	Nuru	Tag	Non, shon
Plain	P'ing	Tala	Tala, Dzhaik	Tkhan
Plateau	P'ing-yuan, p'ing-ti	Khira	Kyr, syrt	Tsan
Water	Sui, shui	Us	Su	Chu
River	He, chiang	Gol, muren	Dari'ya, su	Chu, po
Lake	Hu, hai, po	Nur	Kul'	Tso
Spring	Shui, tsuan y'dan	Bulag	Bulak	Hsi
Forest	Ling	Oi, taig	Oi, tonpoi	Nag, tsal
Desert	Shomo huangmo	Tsel', gobi	Chel'	Tan
Sand	Sha, sa	Elio	Kum	Bema
Snow	Hsueh	Tsast	Kar	Gan
North	Pei	Hoit	Tyundyuk	B"yan
South	Nan	Umuni, urd	Tyushdyuk	Lkho (khlo)
West	Hsi	Barun, oron	Kun-batysh	Nubka
East	Tung	Uzun, dorno	Chygysh	Sham

Adjectives Most Commonly Used in Connection With  
Proper Geographical Names

Red	Ch'ih, hun	Ulan	Kyzyl	Mar
White	Pei	Tsagan	Ak	Kar
Black	Hei	Hara	Kara	Nag
Large (great)	Ta	Tom	Ulu	Chen'
Low	Hsia	Bag	Kichik	Chun, tan

### The Non-Draining Basins

It is estimated that 28,000,000 square kilometers of the earth's surface is covered by areas that do not drain into an ocean. Large non-draining areas are located in Africa, Asia and Australia.

Almost all of Central Asia, with the exception of some border areas, is a great enclosed basin, or rather a combination of a number of large and small enclosed basins which are at the present time frequently hydrographically isolated from one another.

The desert landscape and the lack of drainage are two geographic phenomena which, as a rule, are concomitant. This is clearly demonstrated in Central Asia where, because of moist climates and excessive precipitation, many of the presently landlocked depressions filled, forming residual relict lakes, which could have drained into the ocean by connecting themselves with neighboring rivers. The presently non-draining Koko Nor river, for instance, could have drained into the Kitwong Ho river, the Uliungot lake in Dzungaria could be draining into the Black Irtysh river, and the Telmin-Nur lake could drain into the Selenge basin through the Ider river, and so forth.

At the present there are several well differentiated enclosed basins in Central Asia, such as the Tarim river and Lake Lop Nor basin in Kashgaria, the Dzungaria basin between the Altai and T'ien-Shan ranges, the Depression of the Big Lakes in western Mongolia, especially the enclosed Gobi basin, which is not a single unit, the extensive Tsaidam basin, the Koko Nor basin, and finally the non-draining upland basin of Tibet, fringed by the Kunlun and N'enchen-Tangla mountain ranges. Even though these large enclosed basins of Central Asia are at the present time hydrographically quite isolated, there is evidence that they have been interconnected during comparatively recent geological periods. Such evidence, both geological and biogeographical, points out an incontrovertible connection between some of the enclosed basins, the isolation of which was brought about by both geological-tectonic factors and factors associated with climatic changes during the Cainozoic period.

### Paleogeography

The surface of Central Asia underwent a lengthy period of continental evolution. According to Academician V. A. Obruchev Central Asia was submerged more than once during the Paleozoic period, especially at the start and the middle of that period, which left sedimentary matter, chiefly limestone, which subsequently underwent an extensive metamorphosis. Towards the end of the Paleozoic period the sea in Central Asia occupied progressively less

area, gradually growing smaller. Primary importance is assumed by the continental deposits. Permian marine sediments, encountered in the Gobi, within the borders of the MNR as well as in the mountains east of lake Lop Nor, indicate a shallow and insignificant submergence at that time in Central Asia. The sea was gradually receding westward towards the Turkestan basin which continued to be submerged for a long period of time.

During the Mesozoic period the sea cover over Central Asia was at its minimum. Triassic marine deposits have been discovered at several points in the southern portion of Central Asia.

During the Cretaceous and Tertiary (Eocene) periods only the eastern sea gulf existed in Central Asia; it occupied some of the westerly territories. This gulf covered the southern portion of what is today the Tarim basin (southern Kashgaria, Kunlun). Cretaceous marine deposits are also found in Tibet. According to data furnished by N. A. Belyavskiy, marine sedimentation of Kunlun consists of sandstone, marl and other rocks, 40 to 50 meters in depth. The Eocene sea existed within the borders of western Kunlun only, and did not extend to the east. (1947, page 29)

The Cretaceous sea, covering the Tibetan uplands and reaching the 104th meridian, gradually contracted, and by the middle and latter Eocene and Oligocene periods the major portion of Tibet emerged with the exception of some small areas of southwestern Tibet, which remained submerged until the Neocene period when vigorous uplifting of the Himalayas and their adjacent areas brought about the complete domination of dry land.

An important consequence follows from this, the understanding of which is necessary for a proper comprehension of the further development of Central Asia. It is the fact that by the Paleozoic period part of Central Asia was no longer submerged but had already entered a period of continental evolution. By the Mesozoic period almost the entire Central Asian area had emerged as the sea receded. The continental deposits led to the formation of extensive layers of sandstone, common for this area, as well as argillaceous matter interspersed with layers of various salts, conglomerates, marl, etc.

At the present time, therefore, such terms as "han-hai" See Note 7 and "han-hai deposits" have been forgotten. These terms applied to an incorrect concept of an immense ancient basin (han-hai -- dry sea, in Chinese) and its marine sedimentation. Through geological research it was possible to establish that the multi-colored Han-hai or Gobi deposits are of different periods,

relating to the Jurassic - Pliocene periods and that their formation occurred throughout many lake basins, river deltas, as well as alluvial lake and eolithic deposits.

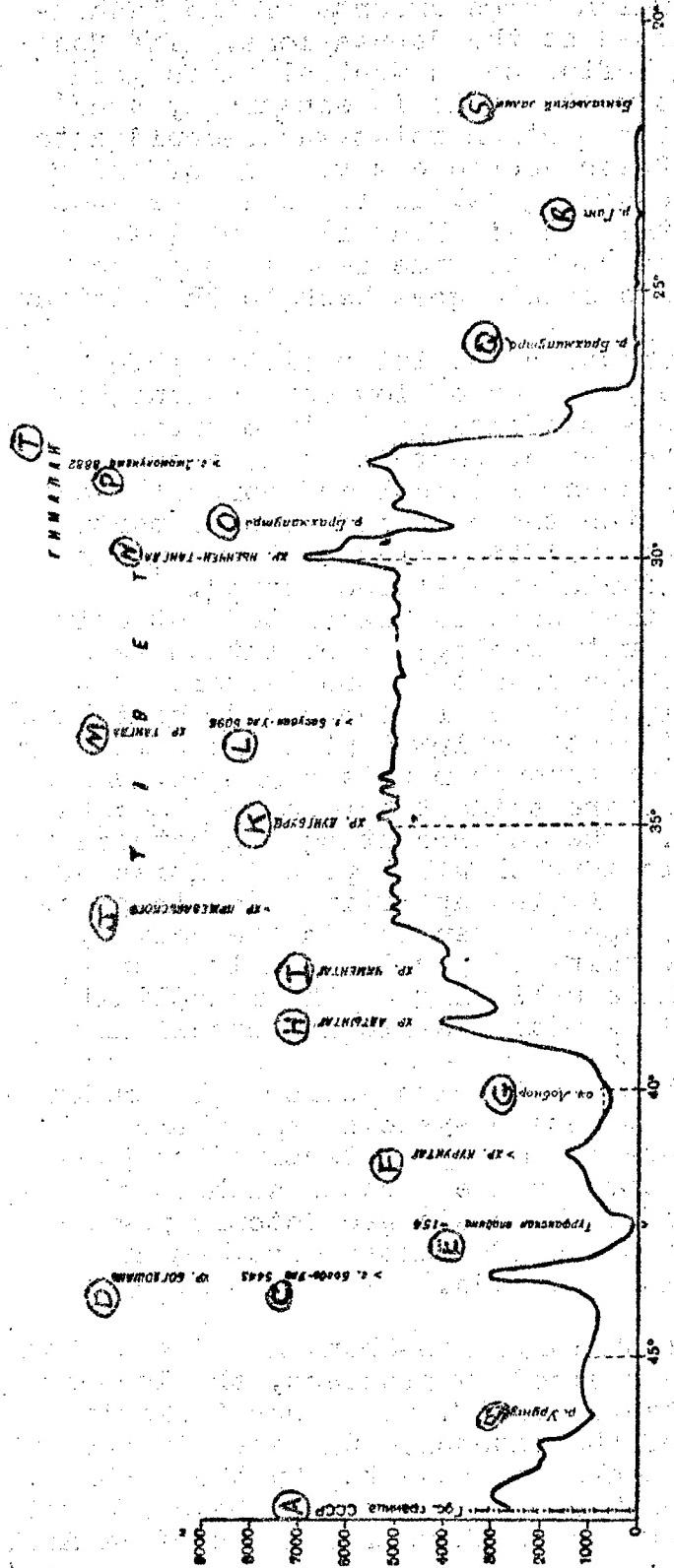
Igneous rock, found throughout most of Central Asia, form entire highlands which are sometimes sharply differentiated by their steep and clearly defined forms. Granite, syenite, porphyry are the most common varieties. Some of the widespread quite recent igneous deposits are basaltic, which form entire plateaus and are sometimes attendant to well preserved volcanic knolls, such as those found in Darigang on the border of the MNR and China, in Inner Mongolia, as well as in the Hangai mountains, especially by the Terkhen-Tsagan-Nur lake (see below).

The paleography of Central Asia, its relief and landscape in general, is closely related to the Tectonic movements which occurred during the prolonged cycle of continental evolution. This is particularly true of the Cainozoic period (Alpine orogenesis), when powerful fresh mountain building movements moulded the geographical structure of the interior portion of the Asiatic continent and had a concrete influence on the character and appearance of the present landscape, deserts and uplands of Central Asia.

Through the entire period up until the present time Central Asia is the scene of powerful dislocations, as a result of which mountain massifs were formed, which were then subjected to denudation during the subsequent period. Orogenetic movements formed a relief of folded mountains. These later underwent intensive water erosion during the first half of the Mesozoic period which brought about pronounced levelling of that area. The outstanding relief features were lowered; the by-products of the obliteration process filled the inter-mountain plains and hollows, raising their absolute hypsometric level. The origin of frequently occurring coal deposits are ascribed to this period, which indicate the presence of a hot and humid climate.

Note Not to be confused with the name of a range in Mongolia "Hangai".

The Mesozoic-Tectonic movements are of great significance in the orogenic history of Central Asia at the time when the ancient folded foundation was remoulded by powerful vertical uplifting. According to V. A. Obruchev, vertical transpositions occurred by the end of the Jurassic period when some regions were raised and others lowered. This phenomena was accompanied by the eruption of rocks and the occurrence of a series of faults. During the subsequent period, that of the Cretaceous and Tertiary epochs, vertical uplifting continued; even though not with the previous intensity, they were similar to those occurring during the Jurassic period.



The hypsometric profile of Central Asia along the 90th meridian.

- Legend:**
- a. USSR border; b. Urungu riv.; c. Bogdo-Ula mts;
  - d. Bogdo Shan range; e. Turfan depression; f. Kuruktagh range;
  - g. Lake Lop Nor; h. Altin Tagh range; i. Chimentagh range;
  - j. Przheval'skiy range; k. Dzungure range; l. Bogd-Ula mts.,  
6,096;
  - m. N'Yenchen-Tangla range; n. Tangla range; o. Dzhomolungma mts.,  
8,882;
  - p. Brahmaputra river; r. Ganges river; s. Bay of Bengal;
  - u. Himalayan mts.;

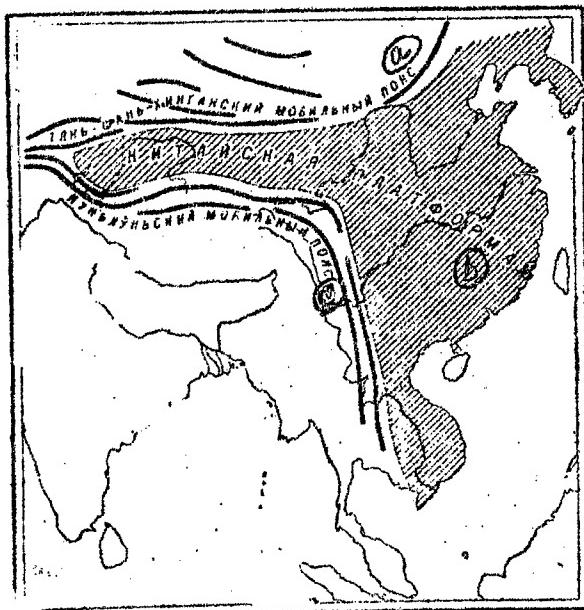
Active mountain building must have caused increased erosion as a result of which large amounts of the washed-out by-products accumulated at the depressions. The Mesozoic cycle had a strong influence on Central Asian geography and on its development. This is especially true with regard to its eastern portion which was remoulded to a lesser degree by the fresh tectonic movements of the subsequent period. Outstanding relief features are seen in the plains of Gobi, the Hentai (Kentei) mountains, Yin-Shan, and other areas such as wide depressions, ancient valleys, etc., whose origin goes back to the distant Mesozoic period.

The present distribution and interrelationship of the mountain ranges, the presence of low depressions between the mountains, the appearance of lofty mountain groups at the southern border of Central Asia, such as the Himalayas, as well as other orographical and morphological peculiarities, is due to the tectonic influences, particularly to the most recent uplifting of the old mountain massifs, which occurred during the Alpine period.

The relief of Central Asia is associated not only with tectonics, but also with geological evolution as a whole, and is frequently the result of the latter. "At the same time the principal relief features and the Alpine structure are in direct relationship: anticline uplifting is expressed in the relief through mountain ridges, while the synclinal deflections are evident between the mountain valleys and depressions. The interrelationship between them is reflected even in morphological peculiarities of the individual units. The Alpine uplifting, for instance, not shattered by faults, appears vaulted in the relief, and uplifting limited by pairs of parallel faults appears in the form of horsts while uplifting of the monoclinal structures on the earth's surface result in monoclinal mountain ridges. . . .

Even stronger relationship with geological construction is exhibited by the mountain systems as a whole. Their location and orientation are predetermined by geological factors exclusively and are located with relationship to the distribution of the basic geotectonic regions -- mobile areas and static massifs, whose development occurs over many geological periods." (V. M. Sinitsyn, 1948, pp 93-94)

Mobile regions of Kunlun, T'ien-Shan, Altai and Nan Shan in Central Asia are divided by plateaus, the largest of which is the Tarim stable massif, which was formerly the western projection of the extensive Chinese plateau. Its separate portions are also represented by the stable Ordos associated with the Tarim massif of the Hansun corridor, which stretches along the northern foothills of Nan Shan.

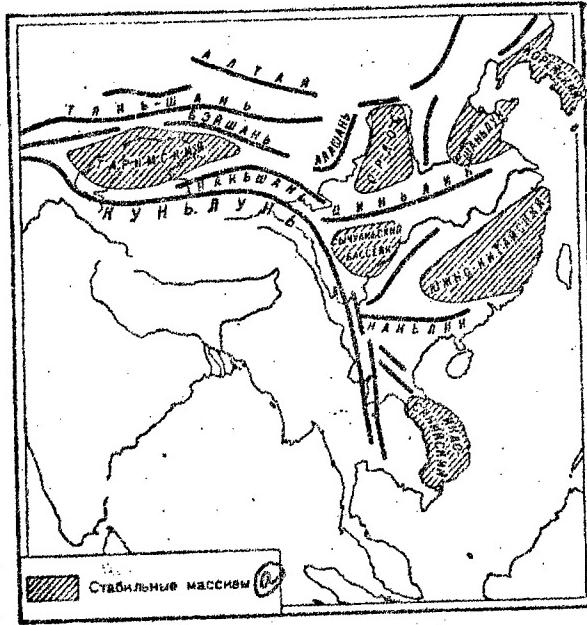


The Chinese shield before the  
Yang Shan(Mesozoic) movements.  
(According to V. M. Sinitsyn)

Legend:

- a. T'ien-Shan Mobile belt;
- b. Chinese shield;
- c. Kunlun mobile belt.

The Chinese plateau underwent several periods of changing conditions -- both continental and marine -- having been subjected to powerful mountain building movements, which enveloped Asia and were marked by the appearance of mountain groups and the splitting of the platform into a number of Tectonic regions. Isolation of the Tarim basin occurred as a result of the Yang Shan mountain building movements, attributed to the Jurassic-Cretaceous period. The most recent continental period in the history of the Chinese plateau began with the end of the Triassic and the beginning of the Permian periods. The fringe of the Chinese plateau consists of mobile regions which were subjected to the strongest influence by the Yang Shan (Mesozoic) and fresh Alpine tectonic cycles. This accounts for the uplifting of Kunlun, T'ien-Shan, Altai, Szechwan (Sino-Tibetan mountains), which were regions of erosion, whereas depressions of the Kashgarian and Dzungarian type were areas where the eroded matter accumulated. As a result of repeated tectonic movements, occurring in Central Asia during the Upper Paleozoic-Tertiary period inclusively,



The Chinese shield after the Yang Shan  
(Mesozoic) and Fresh-Alpine movements.  
(According to V. M. Sinitsyn)

Legend: a. Stable massifs.

a number of fold mountain groups of the Pei Shan, Ala Shan, and other types were formed on the Chinese plateau, which are especially well developed in East China. Such groupings divided the Chinese plateau into separate massifs. Such dismemberment, along with the origination of inter-plateau formations, contain the basic differentiation between the circumstances in the development of the Chinese plateau and of the other stable Eurasian formations.

During the Tertiary period almost all of Central Asia consisted of dry land; a sea gulf existed only in the south of Central Asia (southern Kashgaria, Kunlun). The physical-geographic qualities of Central Asia differed from the present ones. There were no real lifeless deserts at that time either in Gobi, Takla-Makan, or in Dzungaria, even though the climate was of the continental type, dry rather than humid. The climatic conditions, however, were not static but were subject to considerable fluctuations. The general trend was towards an increasingly arid climate.

Fauna excavated in the Gobi depressions, as well as from geological prospecting in Kashgaria, point to an extensive development of lakes and rivers during the Upper Tertiary period. Neocene sedimentation is represented by alluvial and lake clay, marl, sand and pebbles. Extensive depressed areas, such as those in Mongolia, Sinkiang and

Tibet, were covered by water basins; the resultant sediments produced of large mammals: rhinoceros, different varieties of antelope, bison, deer, ostriches, crocodiles, turtles, and fish.

During the Quaternary period the climate became drier. During glaciation the area covered by lakes decreased, even though the melting glaciers maintained extensive basins, such as those in Kashgaria, those in the Gobi depressions, and the depression of the Large Lakes in western Mongolia and that of the lakes in Ordos, Barga and other regions. The Tibetan lakes were covered with ice except for the southern part of the country where the rivers and lakes were seasonally free of ice.

The climatic and landscape changes occurred as a result of processes which are not yet altogether clear, and which accounts for a lack of a commonly accepted point of view regarding climatic changes during the Quaternary period. An indisputable influence on the conditions existing in Middle and Central Asia is the climatic effect of the Alpine mountain building movements which established a high and almost continuous barrier intercepting the predominant air currents. The Indian monsoon formerly brought moisture to northern Tibet and Kashgaria. The Himalayas now prevent it from reaching Central Asia, and the world's heaviest precipitation occurs at the southern slopes of this range not by chance. Pamir intercepts the Atlantic currents; the ancient mountain systems of Kunlun, Nan Shan, T'ien-Shan and Altai rose once again. In the north Mongolia is fringed by Tannu-Ola, Hangai and Hentei; in the east, by the Great Khingan which borders the influence of the Pacific monsoons on the west.

Fresh mountain building increased the dryness, and the deserts must have extended far to the north as the new ranges, which originated at the peripheries of Central Asia, isolated it further from the oceans.

After glaciation evaporation increased, drainage decreased. A xerothermal period occurred. The internal lake basins which played an important role in the Tertiary landscape of Central Asia diminished; many of them ceased draining, and some of them disappeared completely, leaving salt marshes and depressions filled with lake sediments. Rivers became shallow, having lost their secondary tributaries which either dried up or, through isolation, became enclosed. Some of the basic water arteries of the present epoch frequently fail to reach their mouths or the former delta areas. Dryness in the interior areas of Central Asia increased sharply; the role of Eolithic factors increased at a number of regions, such as at Takla-Makan, for instance.

Strand lines indicating higher water levels are recorded at many lakes of Central Asia, such as the K'ko Nor, Gash'n Nur, and Sogo-Nur in the Gobi desert, as well as at the Hiris-Nur lake in the Mongolian People's Republic, and so on. Isolated river tributaries are even more common, such as those of the Kobdo, Kerulen, Tarim, Dzabkhan (at Tazhi) and Sule'e. (at the Lop Nor basin).

#### Excavated Fauna

V. A. Obruchev made an unexpected remarkable discovery in 1892 among the multi-colored Gobi deposits, which Richthofen proposed to name the "Hanzi deposits", considering it as marine deposits. Here is how he himself described it: "I found bone fragments of some animal in the southern part of Gobi, on the edge of a precipice of one of the above plateaus, which was composed of the freshest deposits. This was a most interesting discovery, since for the first time these deposits contained remains which permitted a determination of their exact age. Unfortunately, while I was excavating, my caravan moved ahead a considerable distance. It was therefore impossible to bring it back and make camp for a day in order to make deeper excavations. It turned out later that these remains were fragments of a molar of a rhinoceros dating from the Tertiary epoch, consequently proving that fresh Gobi deposits are not marine, as was previously supposed, but are continental; i.e. it substantiated the fact that Gobi was dry land at that time and not the bottom of a sea." ("From Kyakhta to Kul'dzhu", 1940, pp 27-28)

Discovery of the molar of a Tertiary rhinoceros was the first discovery of the remains of perfectly preserved Cretaceous and Tertiary fauna, which was subsequently found in many depressions in Gobi. Exceptionally well preserved remains of giant dinosaurs, turtles, fish and other animals were discovered in these regions. Remarkable examples of the extinct animals were brought from Gobi to Moscow by the expedition of the Paleontological Institute of the Academy of Sciences USSR under the direction of I. A. Efremov. Upper Cretaceous fauna is fully represented at the State Natural History Museum of the MNR at Ulan Bator. The study of regions where fossilized remains are found permitted the determination of the lake-river conditions during the Upper Mesozoic and Tertiary periods when many local fresh water interconnected basins existed in many of the numerous Gobi depressions, as well as at Takla-Makan. The discovery of the remains of turtles, crocodiles, fish, gigantic carnivorous and herbivorous dinosaurs, and many fresh water mollusks clearly substantiates this.\* (\* Note: See below for the evolutionary history of the Gobi landscapes, where the character-

istics of this desert are given.)

It is interesting to note that the Upper Paleogene fauna at Nan Shan (Humboldt range), as well as in Mongolia and Ordos, is on the whole quite homogenous (deer, rhinoceros, rodents). This indicates the stability of an arid climate in the broad expanses of Central Asia and is most characteristic of Neocene Eurasia and America. Discoveries of the remains of such fauna, made in the MNR, Tsaidam and Kansu clearly indicate that Central Asia is also not an exception in this case. This variety of fauna indicates that a predominantly open steppe or semi-desert type landscape with tree grown oases and lakes existed at that time. The Neocene sediments on the southern slopes of the Himalays bear different characteristics where the well known Siwalik hills are located, which formed as a result of a moist climate and a luxuriously developing forest vegetation.

#### Glaciation

The mountain ranges which rose during the Quaternary period were subjected to glaciation which left its trace on all of the great massifs of Central Asia. Such evidence in the form of glacial moraines, bosses, and glacial valleys are characteristic not only of northern mountain ranges bordering Siberia (Mongolian Altai, Hangui; Hentei) or for the southern mountain chains which, due to their great height and influence of the monsoons, naturally had to be subjected to glaciation, but also of the mountain ranges located in the middle part of Central Asia which already at that time had a dry desert climate. Nan Shan, T'ien-Shan, Kunlun, and other mountain ranges all bear clearly evident and well preserved traces of former glaciation; more than that, they at the present time contain the remaining glaciers.

Present day glaciers occupy a considerably smaller area and are much shorter than those in existence during the epoch of maximum glaciation. However, even at the present time the Potanin Glacier, located in the Mongolian Altai, is 20 kilometers long. Glaciers as long as 15-16 kilometers have been discovered in Kunlun. Quaternary glaciation was distinguished by its scope and enveloped mountain ranges and upland areas where at the present time no glaciers exist at all -- such mountain ranges, for example, as the Han-Huhei, Hanhai, Gobi Altai, and Hentei. It is natural that the Mongolian ranges, being northernmost, were subjected to maximum glaciation. During the epoch of maximum glaciation glaciers located at the upper course of the Kobdo river were as long as 90 kilometers, 100 kilometers in the Ritter mountain range (Nan Shan), and so on.

The issues surrounding glaciation of Tibet were open to debate. Taking into consideration the great height of this upland area, it is possible to logically assume that it was formerly under an ice cover of the ice sheet type, which was penetrated by some of the more pointed mountain summits, free of ice as a result of their shape. There are, however, not enough facts to substantiate this. Signs of glaciation in Tibet are not universally manifest and, if the altitude is taken into consideration, are really comparatively rare. They are mainly ascribed to mountain ranges. The majority of the many Tibetan lakes are not glacial. Some of the largest ones are Lake Yamdok and Manasarowar. It appears that Tibet did not undergo overall glaciation, the reason being its dryness which was inherent to this upland area from the time the Himalayas rose. The pre-glaciation period here was also characterized by dry steppe formations.

Similar conditions were observed in Pamir where, according to the latest research, complete glaciation did not occur and its ancient ice cover, even though it was considerably larger than the present one, was not as large as originally suspected.

E. V. Kozlov, in analyzing the zoogeography and ornithological fauna of Tibet, wrote: "A sharply differentiated endemic quality of the ornithological fauna of Tibet, the presence of unique varieties of birds, most of which inhabit the upland area permanently, indicates . . . an old, at any rate a pre-glacial, presence of these species in this country and, consequently, the fact that they were able to survive Quaternary glaciation at that location. It therefore follows that complete glaciation of the Tibetan uplands really did not occur." (1952, page 1026)

Chronology of the glaciation ages is most complex in general and is particularly difficult to determine in Central Asia where there is still insufficient material available for final conclusions. Judging by the characteristics of ancient glaciation at the Altai and Hangai mountains, it is possible to make a deduction that glaciation occurred twice, perhaps three times, the first occurrence being the most extensive, the following ones being smaller.

Resolution of the question on the frequency of occurrence of glaciation in the mountains of Central Asia, however, cannot be universal. Since the extent and intensity of glaciation varied during its different stages of development, it is natural to suppose that the highest mountains, as well as those mountains located along the peripheral areas with respect to the moist air currents,

could have experienced all three periods of glaciation, whereas others, located in less favorable areas (low absolute height, location in the middle of a desert), show evidence of one or two periods. In the Gurvan-Saikhan mountains of the Gobi Altai, for instance, traces of glaciation are very faint, and it is hardly possible to suppose that a second period of glaciation occurred here. At the same time, under the desert conditions of the Gobi Altai, we must expect to find the best preserved types of glacial formations. In the Ikhe-Bogdo (and the neighboring Baga-Bogdo, which also form a part of the Gobi Altai) the second glaciation period could have come into contact with the deep gorges of the northern slopes where small slope or valley glaciers originated due to an exceptional height of the range (4,000 meters), its favorable exposure towards the north, and the existence of narrow, shady gorges.

The second glacial period was less extensive and, naturally, is far from being universally evident even in the mountains.

During glaciation large amounts of alluvial river deposits accumulated in the form of pebbles, sand, clay and silt at hollows between the mountains, forming thick layers at Takla-Makan parts of Dzungaria, and the Hollow of the Great Lakes in western Mongolia.

#### Most Recent Tectonics

Uplifting movements which occurred at the end of the Tertiary period have not yet ceased. In addition to earthquakes the presence of a large number of active mineral and hot springs -- signs of volcanic activity which occurred during the Quaternary period -- at the present time is direct proof that mountains continued to grow during the post-glacial period. According to observations made by K. I. Bogdanovich, ancient moraines on the highest mountains of Western Kunlun, Mustagh Ata, located at altitudes not below the contemporary ones, even though this contradicts all of the available facts regarding other regions of glaciation.

At the summit of Minyak-Gankar (Gungashan), 7,590 meters, located in the Szechwan (Sino-Tibetan) mountains which are situated under conditions assuring sedimentation, the ancient glaciers descended, according to the remaining traces, only for 200-500 meters below the present ones. The only explanation of these paradoxical facts is the acceptance of the fact that these massifs continued to rise during the post-glacial period, as a result of which the traces of ancient glaciation -- its deposits -- became covered by present glaciation. Approximately the same

conditions were noted at the summit of Nanga-Parbat (8,126 meters) in the Himalayas. The post-glacial up-lifting of mountains is not limited to the above cited examples. It is also characteristic of the eastern T'ien-Shan, Altai, Nan Shan and other mountain ranges of Central Asia, even though the amplitude of the uplifting movements in the Himalayas is, of course, considerably greater than that which occurred in the northern ranges of the region under discussion.

According to research conducted during recent years, it became evident that after glaciation the Himalayas and the Kunlun mountains rose by 1,300 to 1,500 meters -- most impressive dimensions if it is realized that such development occurred during the Quaternary period. The Tibetan uplands also rose along with the surrounding mountain ranges; however the extent of such development was somewhat more limited. V. N. Sinitsyn points out the following curious fact. Shoulders of the south Kunlun range are displaced by 300 meters as compared to their continuation along the Tibetan plateau, which represents the difference in the tempo of the uplifting movements during the post-glacial period.

Not only the vertical uplifting movements, which were characteristic of the second phase of the Quaternary period, must be stressed, but the expansion of their bases as well, which spread over the adjacent foothill plains. Foothill plain areas were drawn into the mountain building movements, forming the lower mountain belts and "counters", as a rule, composed of Tertiary deposits.

#### Denudation

Another factor had a substantial effect on the formation of the present day relief features of Central Asia -- denudation, which is rather vigorous under the specific conditions existing in this region. Great areas of Central Asia are covered by crust -- a common type of relief feature of the Mongolian uplands as well as of Sinkiang and other regions, which is related to the extended period of denudation.

The role of wind erosion during the contemporary period must be particularly stressed. It leads to the destruction of entire mountain massifs, the shifting of sand and dust, and the removal of small argillaceous matter from hollows located between the mountains and even those in the enclosed basin of Central Asia to the peripheral regions beyond its limits. Taking into account the great velocity and persistence of the winds, the sharply fluctuating temperatures, the very dry air, the low level of precipitation, as well as the sparse and scattered

vegetation, the role of wind erosion in the moulding of the Central Asian deserts becomes clear. It must also be noted that the sparse desert vegetation, or the complete lack of it, is particularly conducive to the erosion of the loose desert deposits.

The Tibetan uplands are a particularly clear representation of this. Many travelers noted the presence of a great amount of loose substrata which accumulated in the hollows located between mountains and in valleys. There are large accumulations of rock on the mountain slopes. Due to the dryness, together with protracted periods of freezing temperature, the role of water in the erosion and removal of these deposits is naturally insignificant. The primary role is assumed by low temperature and mechanical erosion. The formation and evolution of the surface of this upland area in Asia acquires primary importance in the explanation of the present conditions influencing the moulding of its relief.

#### River Erosion

In underlining the role of erosion at the present time and during the geological past, it is impossible to overlook the most extensive process of erosion which occurred in the mountainous regions of Central Asia, particularly during the time when its climate was not as dry as at the present time. The observer is impressed by the wide, flat valleys and the concave slopes of the mountain ranges, such as those of eastern T'ien-Shan, Hangai, the Ko ko Nor mountains, which are distinguished by their softness and gentle slopes. Through the broad, flat valleys flow rivers which are very small by comparison with the size of these valleys, which could not have caused the grandiose destruction of the mountain massifs over a short period of time. Many Central Asian travelers noted that at one time erosion by the flowing waters was quite considerable and the remaining traces are clearly evident in the present landscape. The great effect of erosion on the format of the present relief features of the Gobi desert must be particularly underlined, irregardless of how paradoxical this may appear, considering the very light precipitation that occurs here.

Erosion is particularly evident in desert areas where high mountains are found with a great abundance of highly elevated areas, which results in vigorously flowing temporary water flows due to the torrential rains. This, for example, applies to the Trans-Altai Gobi, Peishan, and the Sinkiang foothill region. It is therefore impossible to establish a common denominator between the role performed by erosion on the desert plains of Central Asia

where the relief and a different volume of precipitation do not establish a premise for a similarly vigorous territorial erosion as that occurring in Gobi.

Many geographers and geologists, who have worked in Gobi, underscored the significance of erosion in the creation of pebbles, formerly river (but presently dry) valleys, extensive alluvial cones, and deltas of shallow, broad rivers. In addition to that they make an interesting supposition that the majority of the presently non-draining and desert depressions were originally river valleys. The drying up process in Central Asia, which occurred during the Cainozoic period, caused these hollows to become isolated as the hydrographic network disintegrated into separate segments and frequently disappeared completely. The broad river valleys, therefore, became gradually deeper and more isolated due to the Eolithic processes. It is therefore frequently possible to find regions containing alluvial deposits in the Gobi. Many hollows located between the mountains appear to be strung out in a single line on which a hydrographically enclosed hollow is orographically connected with another likewise enclosed hollow, appearing as its direct continuation. M. V. Pevtsov's "Valley of the Lakes" is a very clear representation of this, where the presently remaining lakes are only remnants of a formerly extensive interconnected hydrographic network. (See below.)

The desert characteristics are: takyr soil, saline soil, non-draining hollows, dry river beds (in Turkic "sai", in Mongolian "sayr"); various types of sandy accumulations and the existence of eroded forms are also common in Central Asian deserts.

#### The Sands

The distribution of the sandy accumulations: the most extensive areas covered with sand are located in southern and middle portions of Central Asia. The sandy relief and their accumulation is associated with the shifting of the sand by the predominating northern, western, and northwestern winds, and in the southwest by northeastern winds. Mountain ranges bordering these sandy deserts on the south -- Nan Shan, Altin Tagh Kunlun, and others -- perform an important role in the accumulation of sand by obstructing the further drift of the sands in the direction of the wind.

Geography of the sandy accumulations and their frequent presence in large hollows indicates that the major portions of these accumulations were brought by other means, such as rivers and water torrents. This has been proved to be the case in the Karakoram desert in Central Asia; the origination of Karakoram sands is asso-

ciated with the voluminous deposits by the Amu-Dariya, Murgab, Tezhen, and other rivers. The biggest amounts of sand are attributed to the Takla-Makan desert. It is not a coincidence that this wide valley between the mountains are penetrated by the waters of numerous mountain rivers of the Tarim basin, most of which at the present time fail to reach the main artery -- the Tarim river. These rivers have their sources in Eastern and Central T'ien-Shan in Pamir along the northern slopes of Kunlun and Altin Tagh. It is natural that the Tarim, Aksu, Khotan, Kashgar, Cherchen, Karashar, and other rivers have deposited, and are now depositing, a large volume of fine sand at the bottom of the hollows. This phenomena must have had a much greater effect in the preceeding damper period when the indicated rivers were much deeper. A large amount of silt and sand was deposited on the Takla-Makan plains during the recession of the glaciers in Kunlun, Pamir and T'ien-Shan.

The former role of rivers in the shifting of sand to the plains may be illustrated on the basis of other sand deposits in Central Asia, particularly those in Dzungaria (rivers of the northern slopes of Nan Shan, T'ien-Shan and the southern slopes of the Mongolian Altai), even though such an illustration will not be as vivid as the preceding one.

The masses of sand encountered in the Gobi are represented by sand heaps secured with brush and frequently by sand mounds. Sand dunes, however, are comparatively rare in the Gobi desert. At Takla-Makan the sand accumulates in gigantic sandy ridges tens of meters in height. Here these ridges extend along the meridian. Loose sand not fastened by vegetation is encountered at Takla-Makan where it gathers into piles of up to 15 meters in height. Also it accumulates into mounds over a hundred meters high at times.

I will cite a colorful description of the Alashan sands of Badan-Dzhareng, contained in a book entitled "Mongolia and Kam" (works of the 1889-1901 expedition under the direction of P. K. Kozlov): "The dunes are bare. A few small bushes are scattered over level ground between them. A strong wind, blowing sand off the dune tips makes them look like miniature smoking volcanoes. The sand stretches still farther to the southeast; dune rises after dune, and one can see nothing beyond a mile beside the bare sand. Not a sound is heard except for the soft shuffling sound made by the camel hoofs on the sand. By morning a heavy frost covers the hills with a silver coating, making them look rather beautiful. The sun rises and the frost immediately begins to evaporate, turning into thin

whirls of steam in the freezing air and spreading in a picturesque manner over the dune slopes."

#### Loess in Central Asia

Loess landscapes are not as clearly evident in Central Asia as they are in North China. They are represented in a more classical manner farther to the east where the loess form layers tens of meters in thickness. Loess is, however, widespread in a number of regions of Central Asia even though here such deposits are considerably less extensive in area and thickness than those covering the Chinese provinces: Shensi Shansi, and the southern portion of the Kansu province. Under conditions existing in Central Asia loess forms the slopes of mountain ranges, such as those among the Nan Shan, Koko Nor, and the Yinshan mountains. In the latter it does not form continuous or large loess regions. The greatest accumulations of loess in Central Asia are located in the southwestern edge of Kashgaria where they are found in the foothill plains between the Kunlun range and the sands of Takla-Makan.

#### Fresh Volcanism

Vivid traces of past volcanic activity have been preserved within a number of Central Asian regions, particularly in the east. Basalt covers over fault effusions occupy extensive areas in Gobi, Northern Mongolia, and southern Siberia. They also exist at Kunlun. Basalt effusions are considered to have occurred during the Tertiary-Quaternary periods and partially, it is possible, during the latter part of the Mesozoic period, which is evident from their positions in the present day river valleys and on Quaternary river deposits. Basaltic effusions, therefore, occurred a number of different times, some quite recently. In addition to the basalt fields in the eastern part of Central Asia, very well preserved extinct volcanoes are found in certain regions there.

Volcanic activity in Central Asia has been known for a long time. The exact time of the most recent eruptions in Manchuria have been established where active volcanoes existed during 1720-1722 in the Nonni basin (Nunkiang) near the city of Nunkiang (Kergen), and which are very well preserved to this time. Quaternary volcanism occurred in Hangai where full variety of volcanic formations is evident at the Terkhin-Tsagan-Nur lake. The freshness of the Hangai volcanoes, lava flows and blocked

valleys prompted some researchers to attribute a post-Quaternary age to the volcanoes of Central Hangai.

An extensive volcanic region is located in the west of the Mongolian People's Republic and in Inner Mongolia. Basalt covers cross into Manchuria, and in the south they are observed as far as the lowlands of Eastern China. A number of volcanic cones are seen within the volcanic region of Darigang (eastern MNR) along with the bordering territory of Inner Mongolia, some of which contain well preserved craters. Extent of the lava streams are easily seen where in spots they have not yet become covered by soil or vegetation. Volcanic activity in this part of Asia was powerful enough to mould a peculiar landscape consisting of undulating plains covered by numerous protruding cones and lava streams. The volcanic region of Darigang and Inner Mongolia west of Khingan connects regions of latter Manchurian volcanic eruptions with Cainozoic volcanism in Siberia, Hangai, and Gobi. The extinction of volcanoes in continental Asia took place from west to east. Presently active volcanoes are known to exist in the Pacific circle; in Manchuria they were active within sight of man during the 18th Century. We are therefore not in a position to finally classify them as extinct. Chinese explorers in our time have observed a smoking, active volcano in Altin Tagh. This amazing fact permits the transfer of the limits of contemporary volcanic activity far west of the Pacific shores. Therefore the volcanoes of Central Asia are the westernmost interior continental group of a combined volcanic region of Asia.

#### Useful Minerals

In a geological sense Central Asia has thus far been very poorly studied. This is particularly true with respect to Tibet. Despite that it is known that a number of most valuable and useful minerals are located here, a part of which have been mined for a long time.

Nephrite has been mined in the Kunlun mountains since time immemorial. It is a famous jade of the Far East, which is used to manufacture various decorations, religious objects, and which, according to beliefs of the eastern peoples, possesses healing qualities. Gold is obtained from the Quaternary alluvial deposits in Tibet, Kunlun, Nan Shan, Dzungaria, Altai, Hangai, Hentei, and Khingan. Non-ferrous and rare metals are mined at a number of places. Iron is found in the Sino-Tibetan mountains and in Sinkiang.

The semi-precious stones of Mongolia are known -- turquoise, topaz, etc. -- and are obtained in the Hentai mountains. They may be seen at the Mineralogical Museum

of the Academy of Sciences in Moscow.

Central Asia is rich in useful non-metallic minerals. Sinkiang contains oil; the western areas of China are especially famous for their Yumen oil fields which face great prospectives. Oil is already being obtained at Yumen. There is much coal in the various parts of China and Mongolia. Coal fields are quite common; lignite coal of the Mesozoic and Tertiary periods forms the predominant variety.

Coal is mined in the eastern part of Inner Mongolia (Barga), in the Mongolian People's Republic (near Ulan-Bator, in the eastern part of the country, and at other places), in Sinkiang and other Chinese provinces.

There are many salt fields in Central Asia, which are situated in the desert plains of Dzungaria, Gobi, regions adjacent to the eastern part of the Mongolian People's Republic, Inner Mongolia and Tibet. Fields of cooking and Glauber's salts, associated with the saline soil and small evaporator-lakes, are common. There are fewer soda lakes and soda strains. Such lakes are found mostly in Inner Mongolia. Soda lakes are also encountered in Tibet, where the indigenous population collect the soda and use it in their homes, drinking it with tea.

It is undoubtedly true that future geological explorations in Central Asia will increase the available number of useful mineral fields, their reserves, and a great variety of them.

#### Atmospheric Circulation

All of Central Asia and Tibet, according to the existing conditions of atmospheric circulation there, fall into two zones: subtropical and moderate. The dividing line between them generally follows along  $45^{\circ}$  within the borders of the central portion of the Mongolian People's Republic and Dzungaria, and emerging at Lake Balkhash. It is determined by the limits of the penetration of hot summer air to the north.

Tropical air predominates the subtropical zone during the summer, which was transformed as a result of a pronounced heating of the continental masses of air of the moderate zone, which is vividly expressed particularly over Central Asia.

A thorough warming of the air masses over Central Asia leads to lower pressure which, however, does not lead to precipitation. This is explained by the fact that the dry continental air is heated over the desert expanses of Central Asia. The location of the polar front which passes over Northern Mongolia leads to the formation of cyclones and to some precipitation; therefore this part of

Central Asia has a higher level of precipitation in the summer than Ordos, Alashan, and Kashgaria.

During winter the sub-tropical zone is governed by cold continental air masses, which move from latitudes farther north in a southerly direction, from the Siberian-Tibetan Anticyclonic center. Its proximity brings forth low temperatures even in southern Kashgaria on one side and coastal China on the other.

Northern Mongolia falls into the moderate zone with a continental non-monsoon climate. In the south this area is fringed by a summer polar front where cyclonic activity takes place during the summer, bringing about a predominance of summer precipitation. In the winter the cyclones are extinguished by the occurrence of a powerful anti-cyclone, which explains why the winds in Northern Mongolia during that time are rather weak. Cloudiness virtually does not exist. Precipitation, as a rule, is insignificant, even though in some years there are heavy snowfalls. The effects of winter currents, moving from the area of Siberian-Mongolian anticyclone to the south into Central Asia, on the formation of desert landscapes is very great. Cold and dry air masses extend to the south and the southwest, having a sharply cooling effect on north China and the southern parts of Central Asia. Along with the intrusion of this cold air very dry weather occurs which is characterized by two factors: 1) the air moves from north to south, from the colder regions to the warmer ones, becomes somewhat warmer, and then moves away from the point of saturation; 2) During the winter cyclonic activity decreases sharply. A high pressure area intercepts the western cyclones and prevents them from penetrating into the middle regions of Central Asia.

The southern current of the Siberian-Tibetan anti-cyclone rests against the mountain barriers such as the Nan Shan and Tsin Ling mountains which, as commonly known, form the most important physical-geographic border of China. The heavy cold air is unable to pass over these mountains and flows to the west and east. In its movements to the south it penetrates the coastal areas of China and brings severe weather with it, which is somewhat softened by the influence of the sea. In its western direction the anticyclone cold air masses reach Kashgaria where, due to the great enclosed hollow located between mountains at a considerable hypsometric level, the winter is sometimes severe with freezing temperatures uncommon for such low latitudes ( $37^{\circ}$ - $40^{\circ}$  lat.).

#### Climatic Characteristics

Climatic conditions of Central Asia are marked by

their highly continental characteristics. Striking data regarding climatic conditions of the interior portions of the Asiatic continent are commonly known: their high summer temperatures and very low winter temperatures, the great scope of the daily temperatures particularly during the summer, the excessive dryness, etc.

It is naturally impossible to expect similar temperatures throughout the vast area of Central Asia. The winter anticyclone performs an important role in the Central Asian climate, the center of which is located at its northern border in Eastern Siberia and the northern portion of Mongolia. The winter in the northern belt of Central Asia and the Mongolian People's Republic is therefore characterized by strong and stable temperatures below freezing; they are not interrupted by thaws. The average temperature in January at Ulan-Bator is  $27^{\circ}$ ; the absolute minimum drops to almost  $-50^{\circ}$ . The sharp drop in temperature is promoted by the winter temperature inversions which occur as a result of the intermountain depressions contained in the relief. The snowfall is light; it remains only in the Altai, Hangai, and in the Taiga Hentai, as well as in Nan Shan and T'ien-Shan. At Kunlun, which is distinguished by its great dryness, the snow remains for a short time only and frequently evaporates rapidly even in the middle regions.

The second peculiarity of the Central Asian climate is the influence exerted by the monsoons of the eastern peripheral portions of this country. A certain amount of virtually insignificant influence by the moist summer monsoons is felt at the Nan Shan range. The effect of the monsoons is far greater in southeastern Tibet. Some authors, however, tend to include Eastern Mongolia right up to the 104th meridian into the monsoon zone, which is in contradiction to the recently gathered facts. In the eastern part of Mongolia the extent of influence of ocean monsoons is limited by the Great Khingan mountains.

The predominantly summertime precipitation is a characteristic of the mainland climate; this characteristic becomes clearly evident in the climatic analysis of almost all of Central Asia. Some predominance of autumn precipitation over the summer rains is noted in Eastern Turkestan only, which is particularly clearly felt in Kashgaria.

The precipitation level in Central Asia (except Tibet) fluctuates between 5-10 to 400 millimeters annually, and a certain area receives 25-200 millimeters of precipitation. The mountains influence the climatic changes of Central Asia. They are responsible for regions with a considerably higher level of precipitation than that of the

plains surrounding them. The significance of mountain ranges becomes very clear in the analysis of wind conditions, where, among the predominantly west and northwest winds, local mountain-valley winds occur; these are especially evident in the northwestern and southern portions of Central Asia (western Mongolia, East Turkestan, Koko Nor etc.).

The following climatic provinces exist in Central Asia, classified according to their common climatic characteristics:

1. The northern strip of Central Asia, i.e. the Mongolian People's Republic, excluding the Gobi strip.
2. Gobi, including the Dzungarian hollow.
3. The Tarim and Kashgarian basins.
4. Tibet, Tsaidam and the adjacent arid regions of Koko Nor.
5. The southeastern part of the Tibetan Uplands.

The northern strip represents a section of Central Asia that is well variegated in flora; forest and steppe vegetation is associated here with both the amount of precipitation and the exposure of mountain slopes. The amount of precipitation fluctuates from 100 to 350 millimeters and possibly more in the mountains; 70 to 80% of this precipitation occurs during the summer.

The predominant winds here are northwesterly and westerly. A great influence is exerted by the local winds. The winds are most constant and strong in the spring, as in the Gobi.

The winters are cold and characterized by an anti-cyclonic regime. During the summer the weather is changeable and is closely related with the cyclones which pass along the southern part of Siberia. The temperatures fluctuate considerably, dropping to  $-50^{\circ}$  during the winter and reaching  $38^{\circ}$  in the summer; daily temperatures differ by as much as  $20^{\circ}$ , especially in the spring. The winter temperature inversion is strongly felt throughout, except at the eastern plain region, which leads to a considerable cooling of the air in the hollows located between the mountains, where the main inhabited areas of the Mongolian People's Republic are located.

Gobi (including the Dzungarian hollow) is characterized by semi-desert and desert landscapes, which are mainly located on plateaus at an average altitude of 1,000-2,000 meters. Alashan and Ordos fall into this category. The extreme southeastern region of Gobi in Inner Mongolia is influenced by the monsoons. This explains why the border regions of this desert receive over 200 millimeters of precipitation with a July average of 100 millimeters.

whereas the main portion of Gobi receives less than 200 millimeters and at times even less than 100 millimeters annually. A characteristic of rainfall in Gobi is the sharp difference in its volume during any two consecutive years. It happens that the amount of rainfall during the preceding year is two or three times greater or less than during the subsequent year. This phenomena yields far reaching physical-geographic consequences, changing the desert landscape into blooming steppes in a single year and steppes into lifeless deserts during another year, which is immediately reflected in the economy, affecting the year round grazing of cattle. It is known that nomad cattle breeding is a leading branch of the population's economy in Gobi.

In Gobi itself summer precipitation is universal with the exception of the western region, in Dzungaria where it occurs during spring-summer. The foothill areas of Dzungaria receive a perceptibly increasing amount of precipitation. Some 295 millimeters of annual precipitation occurs at Urumchi.

The average temperatures increase noticeably from north to south. In the north within the borders of the Mongolian People's Republic the temperature drops to  $-40^{\circ}$ , whereas in the south the temperatures are considerably warmer and the coldest temperatures are  $-20^{\circ}$ ; here thaws are a rare phenomena. The average temperature during January is  $-18^{\circ}$  to  $-20^{\circ}$  in the north and  $-13^{\circ}$  in Dzungaria (at Kuldja),  $-7^{\circ}$  at Lanchou and  $-15^{\circ}$  at Urumchi.

The summer is moderate in the northern part of the desert and hot in the southern strip. The average July temperature at Dzamiin Uude (on the border of the MNR and China along the Kalgan tract) is  $23^{\circ}$ ; the same temperature occurs at Kuldja and Urumchi has a temperature of  $22^{\circ}$  at that time of the year. Maximum temperatures recorded in Gobi do not exceed  $45^{\circ}$  anywhere, i.e. they are lower than those of the Central Asian deserts. N. M. Przheval'skiy recorded a top soil temperature of  $70^{\circ}$  at Ordos on 8 August 1871, while the daily May temperature of the central region of Gobi changed from  $-5^{\circ}$  to  $+32.5^{\circ}$  (a variation of  $37.5^{\circ}$ ).

Winds in the eastern outskirts of Gobi, where the monsoon influence is felt, change periodically; during the summer they are southern and southwestern, during the remaining part of the year they blow from the northwest.

At Alashan, Ordos and the Mongolian Gobi, despite the strong influence exerted by the local winds created by the relief, the predominance of northern and northwestern winds is clearly evident. The western part of Gobi, in Dzungaria, as well as the northern slopes of

Eastern T'ien-Shan and Nan Shan foehn winds are observed. A winter ipieh wind is well known in Dzungaria, which is sudden and gusty as well as very strong and dry. Ipieh blows from the east through the Dzungarian gates into Kazakhstan. In this narrow spot between the mountains it attains great velocity.

East Turkestan is the warmest and driest part of Central Asia. A great hollow circled by mountains, descends quite low to 800-1,000 meters, and some areas are situated even below the sea level (the Turfan hollow -- 154 meters).

Due to a high mountain barrier East Turkestan is a very dry country which experiences almost no northern humidifying influences at all. The desert therefore extends high up into the mountains and occupies areas as high as 2,000 meters in absolute height.

The winds here are generally western, which bring dry air from Central Asia. Central Asian temperatures are striking in their scope; the average January temperatures fluctuate between  $-14.5^{\circ}$  at the city of Kuche to  $-5.6^{\circ}$  at Kashgar; the average July temperature is  $24^{\circ}$ -  $28^{\circ}$ , and at Lukchung as high as  $33^{\circ}$ . Lukchung located in the Turfan hollow is the warmest spot in Central Asia. The average annual temperature here is  $13.5^{\circ}$  and the absolute maximum temperature is  $48^{\circ}$ . Frosts in East Turkestan are frequently quite severe with temperatures of  $-25^{\circ}$ , which again differentiates this climatic province from the other provinces of Central Asia and brings its climate closer to those existing in our Central Asiatic republics.

The level of precipitation in East Turkestan is negligible. In contrast with Gobi and Northern Mongolia the greatest cloudiness occurs during spring and a part of winter. It rains in spring and summer. The annual precipitation level at the city of Kuche is 59 millimeters, and at Kashgar an annual rainfall of 83 millimeters has been recorded. However, the city of Kashgar is located in the foothills and, naturally, in the east. In the center of the desert the precipitation level is less than 25 millimeters and drops to an average of 5 to 10 millimeters annually. Consequently agriculture in the foothill strip is possible only with irrigation.

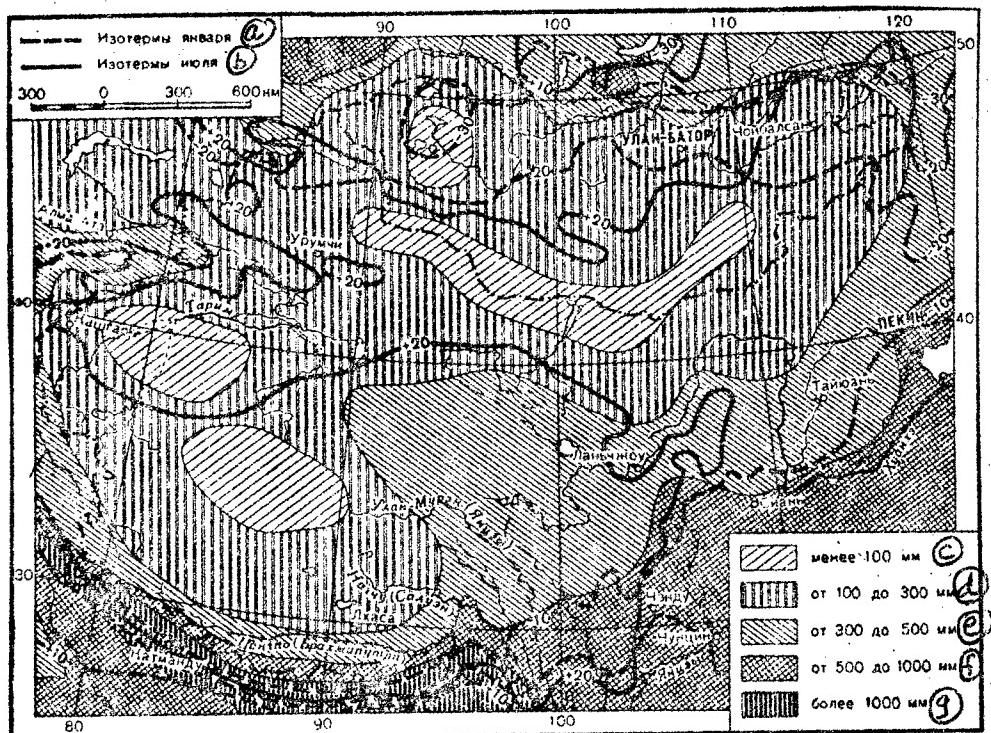
Dusty, dry fogs are common here. Dust storms are frequent in Kashgaria when the winds attain their greatest velocity in February, after which haziness persists for a long period of time -- as long as several days at which time raindrops turn into small lumps of dirt. Finest dust settles slowly and covers all of the ground.

Tibet and its surrounding uplands possess sharply differentiated climatic characteristics as a result of

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their exceptionally high hypsometric level of up to 4,000-5,000 meters. This alone would indicate that the summers could not be warm. The highest average temperature at Tsaidam was  $18^{\circ}$  in August. On the Tibetan plateau the common daytime temperatures are only  $10^{\circ}$ -  $20^{\circ}$  (and sometimes as high as  $30^{\circ}$ ); at night, however, even during July frosts are quite usual. The absolute maximum temperature in the southern part of Tibet in Lhasa is  $33^{\circ}$ , and the average temperature in July is  $16.3^{\circ}$ .

Despite Tibet's high altitude, winter temperatures here are never as low as those in Mongolia, even though the Tibetan winters are striking in their severity. Temperatures rarely drop below  $-35^{\circ}$ . Prezheval'skiy did not observe any frosts with temperatures below  $-33.5^{\circ}$ . In general the temperature of the air over Tibet is higher than



The average annual precipitation and temperatures in Central Asia.

Legend:

- a. January isotherms.
- b. July isotherms.
- c. Below 100 mm.
- d. 100 to 300 mm.
- e. 300 to 500 mm.
- f. 500 to 1,000 mm.
- g. Over 1,000 mm.

that at the same altitude elsewhere. The absolute minimum temperature is  $39.7^{\circ}$ . An absolute minimum temperature of  $39.7^{\circ}$  was recorded in northern Tibet in 1908 at an altitude of 4,430 meters.

Thawing is observed during January. The Tibetan cold weather is very hard to endure for man as it is accompanied by very strong winds and winter storms. A. I. Voeeykov, who processed N. M. Prezheval'skiy's meteorological findings, writes that storms that occur on the Tibetan Uplands in January are as frequent as those occurring in May in Eastern Mongolia -- two days out of three are stormy. The winter is not as windy at Koko Nor and Tsaidam, but the spring is cold and is late in becoming warm. The summer there, however, is warmer than that in Tibet or in Mongolia.

The winds in Tibet are predominantly western, and in the northern part of the country, as at Koko Nor, north-western winds are common, while in the southern half south-western winds occur. A regular shift in the wind up and down the valley is observed -- Dzichou valley where Lhasa, the capital of Tibet, is located.

The Tibetan uplands are divided from India and the Indian Ocean by the giant chain of Himalayan mountains which include the highest summit in the world, bordering with China, Dzhomolungma (Everest), 8,882 meters high. The outside slopes of the Himalayas receive abundant precipitation caused by the monsoons. The origination of the Himalayas led to an increasingly arid condition in Tibet and created extremely desert type landscapes of north-western Tibet. Rainfall occurs at the same time both in Tibet and Koko Nor, principally during the summer. During the winter a continental Asiatic air is predominant here, but the West European air penetrates occasionally, resulting in winter snowfalls. However, it rarely penetrates into the Tibetan Uplands, limiting itself to the western portion only where cyclonic influence is felt. On the whole the northern part of Tibet and Western Tibet receive very little precipitation. A high altitude cold desert is well developed here, non-draining basins are quite common, and erosion is negligible. Even during the months of heaviest rainfalls only 10-25 mm. of rain falls. Precipitation is somewhat heavier in the southeastern part of Tibet, which differs materially from the other parts of Tibet because of its milder climate, and because the effects of the southern air currents, which pass over the lower portions of the Himalayas and bring moisture, are felt here. The regions of upper Yangtze, Mekong, and the middle course of the Brahmaputra receive from 300 to 1,600 or more millimeters of rainfall per year. Some years are very rainy.

During 1935, for example, in Lhasa 375 mm of rain fell over July and August, and the precipitation level for all of 1936 was 5,035 mm. Lhasa is outstanding in its level of humidity. An average precipitation level of 1,600 mm per year is recorded for that area with an absolute maximum monthly level of 655 mm in July.

The southern monsoon is also felt in southeastern Tibet during the summer; its development promotes higher precipitation levels. Moist summer monsoon masses are drawn into low pressure areas in the upper Yangtze, Mekong, and Salween. That is why 90% of the total rainfall occurs during May-September.

A climatic peculiarity of the Sino-Tibetan uplands is a very dry air which is a result of two causes: 1) A low level of precipitation in the west and at the center of the uplands; 2) A great absolute altitude, which is why the humidity saturation of the air is four times less than that of the lower atmospheric layers (B. P. Alisov, 1950, page 99). According to Eastern Tibet it is evident that the second cause is a most effectual one, as the precipitation level here is rather high, but the dryness of the surface of the Tibetan Uplands is reasonably well preserved in this part of it.

#### Vertical Agricultural Borders

It must be noted that it is to Tibet that the cultivation of agricultural crops at the highest altitude in the world is attributed. Common polygonum is grown up to an altitude of 4,270 meters; naked barley ripens at altitudes of up to 4,646 meters; the city of Lhasa has some orange trees which, it is true, yield only small and unripened fruit, but it must be remembered that Lhasa is at an altitude of 3,630 meters. It is here that the uppermost line of vegetation is located. Wooded areas extend as high as 4,600 meters in this region, and grass grows up to an altitude of 6,350 meters. This fact contains an outstanding peculiarity and specific characteristics of the climatic conditions of Highland Asia where the direct effect of the solar, and consequently of the red-yellow radiation, is conducive to a more rapid plant growth and a maximum decrease in their vegetative period.

(G. V. Kovalevskiy)

#### The Rivers

How can the origin of high water, great rivers, be explained under the dry and even extremely dry conditions existing in Central Asia? Two of the greatest Chinese rivers originate here: the Yangtze and Hwang Ho rivers; high water Brahmaputra and Indus rivers have their source

in these Tibetan Uplands, as well as the mighty Mekong and Salween rivers. The Yenisey and Selenge rivers originate in the Mongolian mountains and flow to the north. The sources of the great Far Eastern river, Amur, known here as the Onon and Kerulen rivers, lies in the wooded Hentei range. Irtysh gathers its waters on the southern slopes of the Altai. The Ili and Tarim are born on Eastern T'ien-Shan. Tarim is the only large, completely Central Asiatic river which ends in the sands of Takla-Makan and the Lop Nor deserts.

Let us answer this question. All of the cited rivers have their sources and upper courses within Central Asia, but only on its very edges where the amount of precipitation and the high mountain relief with its eternal snows and glaciers permit great water arteries to originate. It must also be noted that all of the above mentioned rivers attain their highwater marks after leaving the borders of Central Asia. Irtysh, as a matter of fact, may be considered as a great Siberian river only after it leaves Lake Zaisan; Yenisey absorbs most of its water at Tuva and beyond, in Eastern Siberia, having connected with Angara, Tunguski, and other tributaries. The rivers of China and Indo-China -- the Iweng Ho, Yangtze, Mekong, Salween, as well as Brahmaputra, originate on the dry uplands of Tibet, but attain their full measure while flowing through a region known as "monsoon Asia" in Eastern Tibet and especially beyond its borders. Sources of the Amur river, Onon and Kerulen, are actually small rivers, and the latter does not always reach the Amur since it loses much of its moisture to the steppes of Eastern Mongolia and to Lake Dalai-Nur. Only the rivers of western Central Asia, in collecting their waters from the snow capped mountains of T'ien-Shan, Altai, Pamir, Kunlun, and Nan Shan, and flowing into foothill plains, gradually lose their waters, run dry, and disappear in the loose desert deposits or carry their waters to enclosed lakes, keeping them filled. Such rivers include the Tarim, which supplies the Lop Nor and Edzjin Gol lakes, as well as the Mongolian Lake Hara-Us-Nor, the Hangai river of Dzabkhan, whose mouth lies in the Hirgis-Nur, the Tes river which flows into Ubsu-Nur, the Ili river flowing westward towards lake Balkhash and other numerous mountain rivers, shallow in general and which end soon after entering the surrounding mountains, desert plains, and small steppe lakes. Such is the Urungo river, which gathers its waters from the southern slopes of the Mongolian Altai and ends in Lake Uliungor in Dzungaria, as well as the south Hangai rivers -- Baidarig, Tuin-Gol, Tatsyn-Gol, Ongin-Gol, together with the Kuytun river in Dzungaria, which flows into deep water

of Lake Ebi-Nur; the Sulehe river pours its waters into the small Lake Halachi which at one time formed a single lake in combination with Lake Lop Nor. The Bu hym Gol river is the principal tributary of a large Alpine lake, Koko. Nor.

A peculiarity of the Central Asian rivers is their greatest summer high water level, which is a direct result of the rainy period which occurs during the summer season, as well as that of the intensive melting of snow and glaciers in the mountains of Central Asia. The summer high water level of the rivers, which are principally filled by precipitation (Mongolian rivers), bears a sporadic character, depending on the showers and rains which occur at the river basins, when the water level rises sharply within a day or two and then again drops rapidly. High waters in autumn are noted only during years having abundant snowfalls which, due to the conditions existing in Central Asia, evaporate rather than melt.

The rivers of Central Asia are covered by ice for almost six months due to the severe winters and cold spring weather. In Kashgaria the rivers freeze for only three months (December-February).

It is important to note one more peculiarity of the Central Asian rivers -- their mountainous character. Even at present they cause extensive erosion and deposit sediment only at a few spots. There are very few steppe rivers and they are typical mountain rivers at their upper course. The Kerulen river in Eastern Mongolia, the Edzsin Gol river in the central region of Gobi, the Tarim river in Kashgaria, and a few other rivers fall into the above category.

The term "migrating rivers" may be encountered in literature dealing with Central Asia. This term is applied to rivers which change the position of their lower course, sometimes flowing along ancient, abandoned, and dried up beds hundreds of kilometers from their initial position. The Tarim river shifts at its lower course, leaving some river beds and filling others, drying some depressions and entering others. Therefore Lake Lop Nor, discovered by N. M. Prezheval'skiy, was considered by Richthofen not to be Lop Nor since its reported position did not correspond to that shown on Chinese maps. It actually turned out that there are not one but two Lop Nor. Depending upon the course of the Tarim river, either the Lop Nor shown on the Chinese maps is filled (northern depression), or Prezheval'skiy's Lop Nor. Winds and sediment promote the filling of various Lop Nor depressions with water. The sediment is brought by the Tarim river and fill the bottom of the depression.

Another example of a migrating river is Edhzin Gol river which formerly had a river bed, that followed a northeasterly direction from its present mouth and followed into a presently dry Gobi hollow. The famous dead city of Hara-Hoto is located on the dry river bed of the Edhzin Gol river, the excavation of which made most important contributions to archeology and the history of the people of Central Asia. It is known that the Huang Ho river changed its course many times in the Ordos and Altai-shan deserts; Sion, a French geographer, called it a picturesque name, "a foreigner lost in the desert". The lower course of the Huang Ho has been subjected to most extensive shifting as early in its course as East China; it is therefore known to the Chinese as "the river of a thousand disappointments", "the Chinese disaster", "a heart breaking river".

#### The Lakes

Central Asia has an abundance of lakes. The lack of drainage and an arid climate in itself lead to the creation of lakes which are common despite the fact that they may be small, shallow, and periodically dry. Under the conditions of a moist climate these numerous lakes would have ceased to exist a long time ago. It is a curious fact that the driest regions of the Gobi desert are not devoid of lakes which are plentiful in the foothill area of the Mongolian and Gobi Altai and in Dzungaria. They are especially frequently encountered in Western Tibet where a peculiar lake landscape is observed.

Majority of the Central Asian lakes are enclosed and, therefore, as a rule contain mineral water of a varying chemical composition and content. Ubsu-Nur and Hircis-Nur in Mongolia are lakes of this type, as well as Lop Nor at Sinkiang, Kulu Nor south of Nan Shan, Gashun-Nur in Central Gobi. The largest of the Tibetan lakes is Lake Namtso (Tengri-Nur) which is located at an altitude of 4,627 meters. It is interesting to note that some of the enclosed lakes, despite considerable evaporation, still contain fresh or very lightly mineral water. Orog-Nur, Ulan-Nur in the Mongolian Gobi, Hara-Nur, located in a desert depression between Altai and Hangai, are among lakes of this type. This is explained by the existence of either underground drainage through sandy deposits which surround the lakes or by the comparatively young age of these lakes as enclosed containers of water. The level of the non-draining lakes is subject to considerable fluctuation. P. K. Kozlov introduced some interesting data regarding changes in the level of Lake Orog-Nur. It dries up completely during the dry years and the Mongolian cattle

cross it on foot from one shore to the other, while the fish are copped up in small pools of water in some of the deeper hollows. During normal years this lake is from 3.5 to 4.5 meters deep.

Lake Hob so gol (Kosogol) is one of the most interesting flowing lakes, a tectonic reservoir which has the appearance of a miniature Baikal. Lake Buir-Nur, which is a flowing steppe lake, is located in Eastern Mongolia, and the upper courses of Huanghe in the Tsinghai province support two highland lakes described by N. M. Przheval'skiy -- the Orin-Nur and Dzarin-Nur.

It is easy to trace the fact that presently non-draining lakes have in the not too distant geological past been draining. The Telmin and Sangi-Dalai-Nur lakes, which drained into the Selenge and Koko Nor basins and then into the Huang Ho basin, fall into the above category of lakes.

The majority of Central Asian lakes bear very well preserved traces showing their previous high water marks. A higher level of the lakes in Central Asia clearly indicates a process of extensive drying during the Quaternary period and a change in the climate during that time. V. A. Obruchev remarked that Lake Ebi-Nur in Dzungaria bears clear traces of its high water level which was 50 meters above the present level. Similar evidence of a high water level is present at the neighboring group of Alakol lakes. Such traces are very well expressed at the Hiris-Nur lake in Western Mongolia and the Orog-Nur lake in Gobi. G. N. Potanin cites data regarding the drop in water level of Lake Koko Nor and the adjacent small Lake Dere. Lake Dere was once a part of Koko Nor.

Indisputable paleographical interest is presented by the numerous Tibetan lakes, which also bear clearly defined traces of their previous high water levels, noted by travelers. These lakes are principally non-draining and indicate a climate that was becoming gradually drier during the Quaternary period, which must have been associated with the uplifting of the peripheral mountain massifs. We shall now stop at the disputable question of increasing dryness.

#### The Problem of Desiccation in Central Asia During the Recorded Time

The climatic changes that occurred in Central Asia during the time after the Alpine mountain building movements, created present desert landscapes. However, the process of climatic change towards the desert type of climate, which was so pronounced during the post-glacial period, is evident during the period of recorded history

as well. Heated polemics on the subject of the drying process occurring in Central Asia during the last 1,000-2,000 years have been continuing for some fifty years.

Many authors have expressed a point of view on the progressive dehydration of Central Asia during the current period of history after taking into consideration factors affecting a drop in water levels of the lakes, the isolation of tributaries from the rivers, the discovery of cities in what are now waterless deserts, and the covering of plowed land with sand. Such a point of view was taken by E. Hettington, A. Stein, P. Kropotkin, G. Grumm-Grzhimaylo, and lately, V. Sinitsyn. The opponents of this point of view were A. Voyeykov, L. Berg, I. Val'ter, and recently, K. Markov.

V.M.Sinitsyn correctly stresses the role of the fresh tectonic movements in the changing climate of Central Asia during the Quaternary period, which was previously pointed out by many explorers of Tibet, China, and Mongolia.

V.M.Sinitsyn applies his contentions to the contemporary historical period as well. In agreeing with the reasoning of the opponents of the theory of dehydration with regard to Central Asia and some other theories, he maintains that the Central Asiatic climate continues to become drier.

V.M.Sinitsyn's argument regarding the influence of the rising mountains along the edges of this mountainous country on its increasing dryness is impressive. In principle this is not objectionable. Such a position is quite tenable and competent, which has already been observed in literature, particularly by E. Murzaev in 1946 [See Note 7], when the dependence of Mongolian climatic conditions on the Alpine mountain building was underlined, which, it still seems to us, is not the only factor causing an increase in the desert conditions in the northern portion of Central Asia. V.M.Sinitsyn, however, was the first to pose categorically the question regarding the significance of the Alpine uplifting movements as barriers obstructing the winter anticyclonic air masses within Central Asia, which, of course, increases the desert characteristics of its landscape. This must be fully agreed with, taking into consideration the consequences of this phenomena: almost a total absence of precipitation (or a negligible amount of it) falling during the cold period of the year, low winter temperatures, strong insolation, virtually no clouds, and as a result significant surface evaporation. All of these factors have in many respects, but not entirely, predetermined the desert type landscapes of Central Asia during the last period of the geological past, i.e. during the extensive Tertiary-Quaternary period of the earth's history, particularly since the Pliocene period.

Note Basic problems of the physical-geographic study of the MNR. "Probléms of Physical Geography", issue 12, Moscow, 1946, pp 74-75.

These contentions, however, explain little if they are applied to the explanation of the reasons for the supposedly progressive climatic change in Central Asia towards dehydration during the historic period.

Can the extent of the uplifting of mountains of Central Asia during the historic period play a material role in reinforcing barriers against the Siberian anticyclonic air masses? Does it make any difference in this case whether the average height of Kuhlun and the Himayayas is not 6,000 but 5,900 meters or even 5,500 meters? The Siberian anticyclone, losing its power at the peripheries, could not have passed over altitudes of even 4,000 meters, especially in view of the fact that its cold air masses compose a heavy and almost immobile combination.

V. M. Sinitsyn's contentions were examined by K. K. Markov in his article entitled "Are Central and Middle Asia Becoming Drier?" (1950). K. K. Markov, in analyzing the factual material on the position of the lake levels and the character of their deposits, asserts that Middle and Central Asia are not experiencing progressive dryness during the historic period. According to K. K. Markov's opinion the thesis of proponents of the theory of desiccation of Central and Middle Asia is not substantiated by facts:

"During a long and early epoch from Upper Cretaceous to the Glacial periods Eurasia was enveloped by drying and cooling processes. Steppes and deserts were constantly expanding into forest areas" (page 116). The process of dehydration, therefore, during the geological past was not a local phenomena, which is now occurring in the regions of Middle and Central Asia, but was much broader including great areas of the Eurasian continent.

While analyzing climatic tendencies occurring during the historic period it is also necessary to take into consideration the changing landscapes which are a result of the physical-geographic conditions, principally climatic, together with the change in landscapes and an increased dryness as a result of secondary physical-geographic conditions and man. The latter is understandable. The changes in secondary physical-geographic conditions may occur irregardless of the climate or man. An even increase in the alluvial deposits and the creation of thick layers of pebbles and sand in the foothill area, for instance, where the rivers leave the mountain, with time leads to an increased filtration of the river waters and to the eventual disappearance of the lower course of such

rivers. The increase in alluvial shelves and in loess covering at the lower belt of mountain ranges may be associated with the disappearance of springs, ground water, etc.

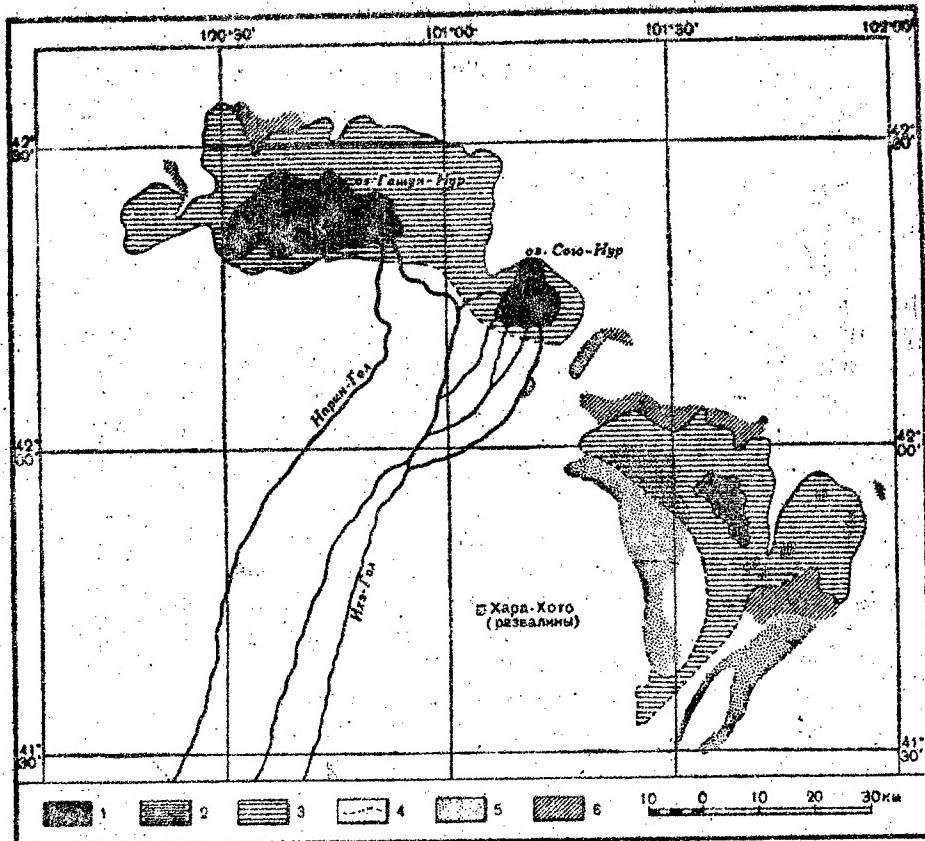
Man's effect on the appearance of the desert is quite variegated. Man has felled trees and shrubbery, destroyed the grass sand cover through excessive cattle grazing as a result of which the sands began to shift with the winds, took water from rivers for irrigation at their middle course without considering the resulting dehydration of the river below that point, and the consequent destruction of oases in its lower course. Wars have brought destruction of man made irrigation systems with a resulting expansion of the desert areas.

Uplifting of the Central Asian mountains during the present epoch is occurring very gradually and it may hardly be taken into consideration in explaining the climatic changes that took place in Central Asia during the historic period.

Geologists who worked in the Kunlun mountains and the Himalayas cite data which permits us to assert that these mobile regions have risen during the post-glacial period by 1,300-1,500 meters. Such data may be found in works by N. A. Belyavskiy and V. M. Sinitsyn. In this case the average annual increase in the height of the mountains may be measured in 10-15 centimeters. Considering the fact that the Central Asian Golotsen period lasted for 10,000 years, during the last one thousand years of the existence of Central Asia forests, located along the edges of the Takla-Man desert, perished, and other signs showed its progressively increasing dryness, mountains intercepting the moist southern air currents became only 100-150 meters taller. This is such a negligible increase particularly by comparison with the absolute height of the Himalayas and the Kunlun mountains, that it may really be disregarded.\* (\*The average absolute height of the Himalayas and of the Kunlun mountains is considered to be 6,000-6,100 meters. Consequently the extent of mountain growth over a thousand year period is equal to less than 0.02 of the average absolute height.)

Facts observed in nature contradict contentions regarding the change in climate of Central Asia during the historic period, but, as it was evident from all that was discussed above, direct assertions regarding climatic dehydration during the Quaternary period are made. Traces of extensive dehydration must be attributed to the xero-thermal period which was experienced by Central Asia after the epoch of glaciation.

By using the cities of Hara-Hoto at the lower course of the Edhzin Gol or the cities of Takla-Makan as an ex-



Ancient and present day lakes in the Edzjin Gol lowland  
(According to Gerner and Chen, 1935)

- 1) Present day lakes; 2) Lakes which disappeared during historical time; 3) Ancient lakes with well preserved shores; 4) The assumed shoreline; 5) Sandy dune regions; 6) Basic mountain rock being exposed in direct proximity to lakes and rivers.

ample it becomes evident that they perished because of a change in the course of the river's tributaries or of its main body. Shifting Central Asiatic rivers have already been discussed above. The dispersion of sand in a number of regions of Gobi and Dzungaria is explained by the activities of man. As a result of the historical-economic reasons the people leave one place, migrating elsewhere. Abandoned oases disappeared as the water arteries nourishing them became clogged, eroded, and useless.

Opinions regarding the dehydration of lakes are justifiable only together with a consideration of the periodic changes in the water levels, both increases and

decreases occurring as a result of the climatic conditions over a number of years, which is what is taking place at a number of places on the surface of the earth. This is especially evident in those enclosed basins which are under desert climatic conditions with considerable summer evaporation. In addition to that a lake is a comparatively recent phenomena in the history of the earth.

There are factors which specifically refute assertions regarding a progressive dehydration of Central Asia. In the north of Mongolia, for instance, where the forest is situated in its southern portion, a well established and rapid reforestation is quite noticeable: larch and pine trees. In addition to that a concerted movement of the young forest into the steppe areas is observed. According to observations conducted during recent years in Gobi, good reforestation and growth of various types of young poplar and desert Gobi elm trees are progressing well.

Interesting analysis of the dynamics of the climatic processes during the historic period was made by a Chinese scientist Chou K'e-cheng (Ku Chin-ch'u). Material describing his research was published by A. B. Markuev (1947) and K. Brooks in a well known monograph entitled "Climates of the Past" (Russian edition, M. 1952).

It appears that an examination of archives permits the discussion only of "pulsation" in the rate of precipitation and the course of the temperatures, but not of the tendencies in the climatic changes towards an increase in the dryness in North China. The study of a number of years during which either floods or droughts occurred within the past centuries indicates a predominance of floods over droughts. K. Brooks points out in this regard that the 4th, 6th, 7th, 15th, and 16th centuries were characterized by comparatively dry conditions, while the 2nd, 3rd, 8th, 12th, and 14th centuries were more humid.

There is therefore no basis, either theoretical, historical, or practical, to talk of "dehydration" of parts of the Asiatic continent during the past several thousand years.

#### Distribution of the Soil Cover

Central Asia is a country predominantly consisting of deserts and steppes. It is therefore natural to expect the widest distribution of various chestnut and brown soils here. It is true that the zonal soils will be the above varieties. However, the complexity of the relief features stipulate a considerably more variegated soil covering, where various desert types of soil are represented on the one hand and mountain soils which have formed as a result of their vertical formation on the other.

Chernozem and gray types of soil are encountered in the north of Mongolia on the mountain slopes; however, the zonal types of soil here are the dark chestnut, chestnut, and light chestnut soils. The last two types are particularly well represented in Eastern Mongolia and the northern portion of Inner Mongolia, where on the east they are fringed with the forest soils of Khingan. Mongolian chest-soils are characterized by the absence of alkali.

The northern portion of Gobi is covered with brown soils, as a rule not saline, of a light mechanical composition, sandy in places. Alkali soil, saline soil, takyr soil, and sand in various combinations are usually found in the numerous Gobi depressions. Gobi mountains contain skeletal brown and thin layers of chestnut soil. The Alpine belt contains mountain-meadow soil. The low Gobi highlands are rocky, bare, and have no soil covering. Mountain pedestals are covered with brown soil containing a small amount of humus; this type of soil contains gravel. The surface of the Gobi brown soils is frequently covered with fine pebbles and gravel forming a "stone shield".

Stony soils are quite common in Dzungaria where they cover wide areas along with sand, which is especially characteristic for the interior parts of this country.

Sandy deserts are characteristic for the interior portions of Kashgaria and Ordos as well. They are well represented in Lasashan and partially in Peishan. At Kansu, in the Pre-Hangan region of Gobi, as well as on the border of the Mongolian plateau and in the hills of North China, chestnut soils of varying colors appear once again, occasionally alternating with brown and gray soils. Chestnut soils here are almost exclusively found in the loess region.

Vertical zoning is clearly differentiated at Nan Shan where the change from light chestnut soils to the mountain chernozem soils and to mountain-meadow soil is noticeable. The high valleys of Nan Shan which are located at an altitude of 3,500 meters are dressed in chestnut soils.

Gypsum and stony soils are found south of T'ien-Shan. The zonal soil of the T'ien-Shan and Kunlun foothill areas is the light gray desert soil which formed under very dry conditions. It is important to note that the extreme dryness of Kashgaria stipulates the presence of desert gray soil at uncommonly high altitudes. On the Kashgaria and Kunlun mountains, for instance, chernozem soil extends to an altitude of 3,500 meters and to 3,200 meters on the southern slopes of Eastern T'ien-Shan.

Stony soils are well developed in the foothill areas of T'ien-Shan, Kunlun, and the Dzungarian mountains, which

create a desert landscape.

Mountain-meadow and mountain alkali soils are encountered in Gobi cases and the foothill areas of T'ien-Shan and Nan Shan, where ground water is in abundance. Such areas are covered by a dense vegetation that thrives on warmth and moisture as a result of which these soils contain a large amount of humus. Multicolored and alluvial soils are common for river valleys where plots of meadow, marshy, alkali, takyr, and primitive carbonic soils may be found. Example: the Tarim basin and the great Lop Nor lowland where alkali and sandy soils predominate.

The Tibetan upland desert contains desert gray soils in non-draining depressed areas; enclosed salt lakes are surrounded by widespread salt flats, which form as a result of the dry conditions. The greatest amount of saline matter is found at Tsaidam -- the gigantic, non-draining depression where large massifs are sometimes formed by the sands. The isolated types of relief features in Eastern Tibet play a leading role in the moulding of the landscapes. The soil covering is therefore quite multicolored and is subordinated to vertical zoning factors. In the southern regions in some of the abundantly watered depressions signs of soil lateritization appear.

#### The Distribution of Vegetation

Landscapes of Central Asia were formed in accordance with those basic factors which had a decisive influence on the development of that region. The high hypsometric level of this region, a barrier of grandiose mountain massifs on its borders, alternating periods of humidity and dryness but generally dry climatic conditions, glaciation which encompassed the basic mountain groups of

Central Asia -- these are the basic circumstances which led to the formation of the present day landscapes of Central Asia. These landscapes are most variable if the great size of this region is taken into consideration. It would still be incorrect to state that an arid climate left its mark on their diverse appearance. Whether it is the forest-steppe of Northern Mongolia, a high mountain cold Tibetan landscape, the deserts of Takla-Makan, gravel semideserts of Gobi, or the alkali flats of Tsaidam -- a strong lack of moisture is felt everywhere.

The greatest areas of Central Asia are covered not by unfertile deserts, as it is commonly thought. Scientists, studying the vegetation of Central Asia, have a long time ago arrived at the conclusion that a large portion of Gobi, the great Asiatic desert, is not formed by desert landscapes, but is rather represented by semi-

deserts and dry steppes. This point of view is receiving considerable recognition over the past several years. It is true that all of the eastern part of Gobi is a semi-desert and dry steppes comparatively well provided with fresh ground water. Real deserts, as a rule, are covered with pebbles or gravel and pebbles with a widely scattered type of vegetation; such is the Trans-Altai Gobi. Great expanses of desert are covered by sand, but bare sand dunes devoid of all vegetation are far from being everywhere. Large sandy deserts are Takla-Makan in Kashgaria, Badan-Dzareng in the Alashan, and the Ordos sands in Dzungaria. Saline flats are well spread out in the depressions located between mountains of the Gobi Altai, Eastern T'ien-Shan at Altin Tagh mainly between the last range and Kunlun where the colossal Tsaidam saline depression is located. Saline areas with the attendant vegetation that thrives on salt are frequently populated by Mongols and Tanguts who utilize those areas as grazing country. The northern periphery of Central Asia is formed by the Mongolian steppes which have been described by our travelers on a number of occasions. Vegetation here consists principally of sagebrush and various grasses. Northern Mongolia at Hangai, Hentai, the mountains of Lake Hobsogol is represented by forest-steppe and chestnut soil landscapes. Here forests cover the northern and northwestern slopes and is composed primarily of larch and partially of pine trees, together with a few cedar trees. Deciduous forests have a secondary importance; the former consists of birch groves which are sometimes mixed with coniferous forests such as those, for instance, in the northeastern part of Mongolia.

The region being described is penetrated only by the edge of the Siberian taiga which forms massifs in the mountains of Prehobsogol and Hentai. Forests are common on the Sinkiang slope of the Mongolian Altai and the northern slope of T'ien-Shan.

Transition from one physical-geographic zone into another is very sudden as in the northern region of Central Asia.

The typical Trans-Altai Gobi lifeless area is separated by only 700 kilometers from the taiga region. Beside the effect of a different latitude accounting for such a rapid change in landscapes from north to south there are other influencing factors. Of great significance is the change in the relief from a mountainous one in the northern part of Mongolia to a plain relief in the south. On mountains having a northern exposure the forest is able to penetrate much further south than it would have on a plain or a hilly relief. Along with that there is

the effect of decreasing absolute altitudes once again from north to south. In addition it is impossible to disregard increasing degrees of continentality, dryness, and temperature differences which occur in the southerly direction towards the interior of Central Asia. As a result of all this the number of desert regions increases sharply.

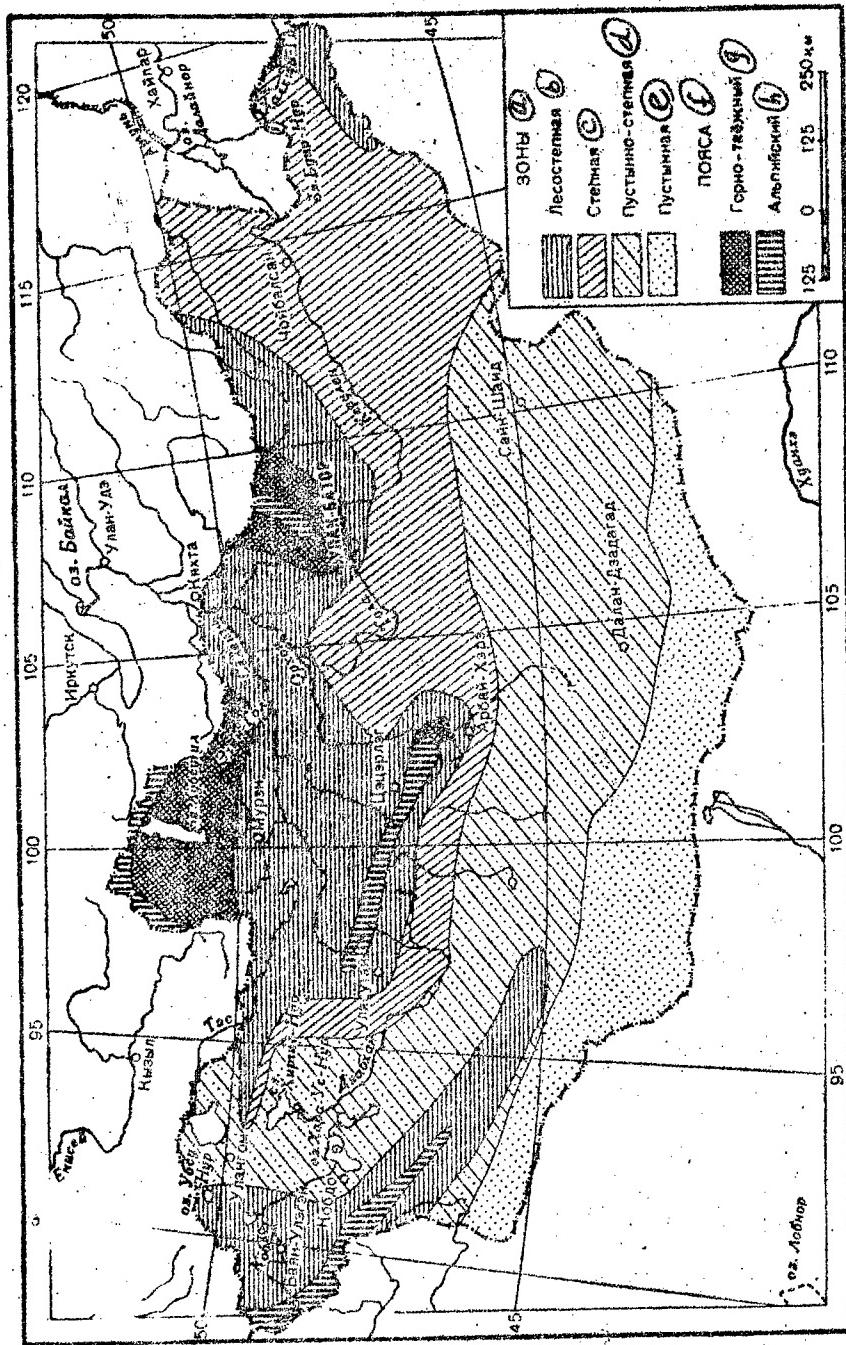
The variegated nature of Central Asiatic landscapes is promoted by the presence of Mountain ranges and high altitude upland areas, as well as above-ground water sources that create oases in the deserts. These factors are particularly evident in the southern half of Central Asia, in Tibet and Kashgaria.

Due to the emerging mountain rivers and ground water at both foothills of Eastern T'ien-Shan the richest oases, composed of both wild vegetation and particularly of the various agricultural crops, with dense population and large cities, have sprung up at the northern foothills of Nan Shan and Kunlun. Urumchi, Hami, Karashar, Hotan, Yarkand, and some others are such oases.

Rivers, in crossing desert and semidesert areas of Central Asia, create a strip which is sharply differentiated by its colors on the brown background of the surrounding plains. Edzin Gol, taking its course from Nan Shan, traverses Central Gobi irrigating a wide valley on its way and creating possibilities for the Mongols-Tanguts to conduct agriculture. This applies even to a greater degree to the river Hwang Ho which crosses the desert areas of Ordos and Alashan. Finally, emerging springs of ground water at the foothills of the dry Gobi mountain summits or at Gobi depressions between the mountains create islands of luxuriant and green vegetation which pleases the eye by its fresh colors. This is reed country; tall euphrates poplar trees stand out in spots.

Great mountain ranges and highest plateaus bear all the signs of vertical zoning. The eternal snows of Mongolian Altai, Nan Shan, T'ien-Shan and Kunlun alternate with Alpine meadows and even forests, such as the case, for example, on the southern slope of the Mongolian Altai at the source of the Irtysh river, where larch are present, or the fir groves at T'ien-Shan, and the juniper groves and partially fir groves at Nan Shan, as well as mixed forests at Alashan. Rocky, highland, and cold deserts predominate western Tibet due to its dryness and high altitude, while the damp depressions contain meadows and swamps.

Most striking in its variety and wealth is the vegetation of Eastern Tibet, where an abundance of precipitation and a milder climate than that at the Tibetan Uplands creates an alternating forest (from the bottom up),



Vegetation zones of the MNR. (According to A. A. Yurnatov)

**Legend:** a. Zones; b. Forest-steppe; c. Steppe; d. Desert-steppe;  
e. Desert; f. Belts; g. Taiga-mountain; h. Alpine.

with first a predominance of pine trees along with oak and maple, after which spruce, yew, and fir grow to altitudes of up to 3,000 meters; fir gradually becomes the predominant variety. Rhododendron forms a belt at 3,600-4,200 meters, above which Alpine vegetation is found.

#### The History of Vegetation

Variety in the landscapes of Central Asia, its great size and proximity to territories having large geographically outstanding features (East China, India, Siberia, Soviet Central Asia) -- all this has brought about vegetation that is not specifically peculiar to Central Asia, but has developed to a great degree under the influence of flora found in the neighboring countries. Severe natural conditions which existed in Central Asia during a geologically lengthy period were not very conducive to the development of a large number of specifically Central Asiatic varieties, as a result of which the process of evolution of such varieties was very slow. Academician V. L. Komarov notes: "Mongolian flora is not homogeneous; the admissibility of the term 'Mongolian flora' may even be doubted since the vegetation covering Mongolia does not represent anything that had its own center of development and its own history. It is rather a Central Asiatic desert-steppe flora, composed out of xerophytic plants of various mountain types of vegetation."

However, it does not mean that primordially local varieties of plants originated here, even though for a long period of time, since the Mesozoic epoch, no part of Central Asia was submerged but rather had a continuous continental regime.

Just 50 years ago there was a popular scientific theory that Central Asia, even during the Tertiary period, was covered by the "Hanhai" sea, which is why the vegetation of this region could have originated only during the Quaternary period through the movement of vegetation here from other regions. In actuality, however, the continental regime of Central Asia, as pointed out, has existed for a considerable period of time, and this could not have failed to have an effect on the local evolution and the migration of Central Asiatic plants to neighboring regions: Siberia, Kazakhstan, and East China. Such migration must have achieved its highest intensity during the post-glacial drought period when in the valleys and depressions between the mountains the individual varieties of Mongolian flora reached high latitudes and covered low altitude steppe areas, even at Yakutiya.

The forests of Hangai, Mongolian Altai, Hentei, and Khingan are the continuation of Siberian forests. Daur

elements perform an important role in the flora of Northern Mongolia. Chinese flora has a strong effect on the composition of the vegetation in the southwestern part of Central Asia where the desert conditions become somewhat milder. The influence of ancient Mediterranean elements from Middle Asia is felt in Kashgaria. The latter are better represented in Dzungaria which has a somewhat richer variety of vegetation than arid Kashgaria. Kashgaria is striking in the limited variety of vegetation found there. This is explained by the fact that its deep depression is fringed on all sides by the greatest mountain groups which intercept the migration of the majority of the forms of vegetation from three directions, with the exception of the east. The east, however, is governed by the Gobi desert where evolution processes are very slow and the density of vegetation is negligible.

Due to a severe climate, a short summer, and most important, a late and dry spring, ephemeral vegetation, which is so characteristic to the plains of Middle Asia, is absent from most of the regions of Central Asia. This spring vegetation appears only in Sinkiang, particularly in the western part of it, which possesses certain common characteristics with Soviet Middle Asia. Summer, when it rains in Central Asia, is marked by a vigorous growth of the vegetation, which is why the vegetative period in Central Asia is quite late and is shifted to the summer. Glaciation had a powerful effect on the history of the vegetation and the fauna as well. Present day Tibetan vegetation must be examined as a reasonably young variety which has formed during the post-glacial period. Such formation occurred with the aid of Chinese, Himalayan, and Burmese flora. Only about 12% of all the Tibetan present day flora relates to typically Central Asiatic varieties. Therefore with regard to flora Tibet and the adjacent Koko Nor region are distinguished from other regions of Central Asia.

It does not follow, however, that glaciation destroyed all of the pre-glacial vegetation of Tibet. As we have already pointed out, it was impossible to expect complete overall glaciation, and if so, then some Lower Quaternary and Upper Tertiary flora must have been preserved in the intermountain plains and valleys (even during the period of maximum glaciation on the mountain ridges). This is indicated by the following fact: the interglacial deposits at Lake Pangong (southwestern part of Tibet) have been found to contain some pollen from typical Tibetan and generally Central Asiatic plants -- winterfat, joint fir, and bayberry, which are at the present time well distributed and in some places are background

plants, forming the vegetation of widespread mountain desert regions. (E. V. Kozlov, 1952, page 974)

#### The Crops

A great majority of the crops cultivated in Central Asia have been imported from the neighboring countries. Only a few of them are local in origin, coming from the high upland areas and desert depressions of Sinkiang and Mongolia.

It has been noted that by comparison with Middle Asia, East China, or Afghanistan, only a few crop varieties have received widespread agricultural application. The internal crop diversity is also not very extensive. Such a crop as rye is completely non-existent in Central Asia. Wheat, barley, flax, and cotton were brought to Sinkiang from southwestern or eastern Asia. Barley is the most widespread grain crop in Central Asia. It is common to Mongolia and Tibet, but is rather rare in Kashgaria. Naked barley, which is cultivated in Mongolia, is Chinese in origin; it is greatly frost resistant and has a short vegetative period, which is especially important for survival under Central Asian conditions. Many vegetable crops have penetrated here from China in addition to polygonum, millet, rice (which is entirely absent from Tibet), and the opium poppy. Orchard crops in Sinkiang are borrowed from Middle Asia or Afghanistan and Iran; these include: apricots, myrobalan plum, pomegranate, almond, as well as different varieties of grapes. Apricots grow at high altitudes in the southern part of Tibet and form the principal fruit crop there, having great food value.

What crops originated in Central Asia? One such crop apparently is hemp, which occupies great areas in Dzungaria. It spreads to Siberia and the Far East as a weed plant. Wild chicory is quite common here, as well as wild carrots, wild apples (T'ien-Shan); these plants, however were not first cultivated in Central Asia.

#### The Animal World

The animal world of Central Asia is of interest. Such an interest is stipulated not only by the existence of some very rare animals there at the present time, principally ungulate, but also by the fact that the interior portions of this continent are regarded by many scientists as an ancient center of development for many of the desert and upland varieties of animals, and as the original home of many of our own ungulate animals.

Zoogeographically, Central Asia relates to the Central Asian sub-area which occupies the southern portion of the vast subarctic region. Some zoographers separate Tibet

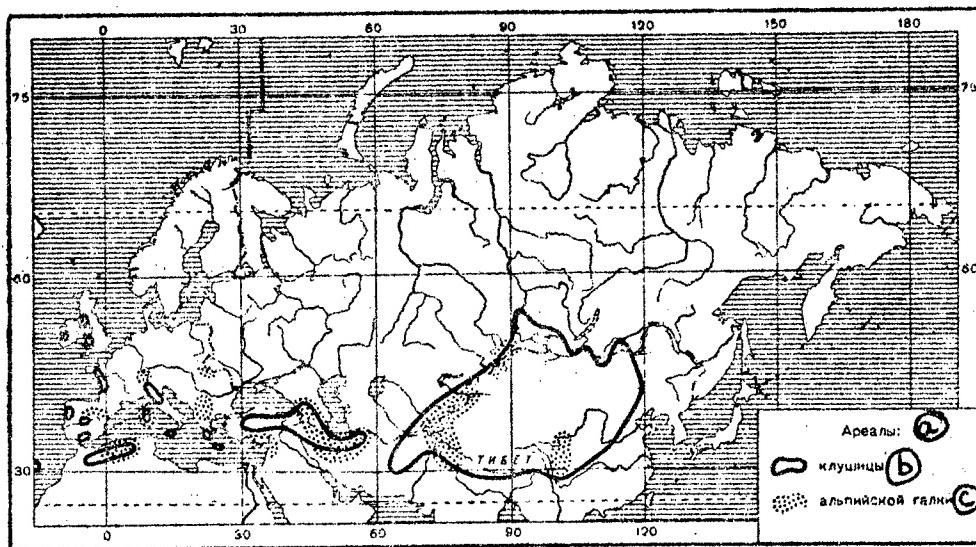
from the Central Asiatic sub-area and regard it as a part of the Himalayan-Chinese sub-area. Central Asia remained above the sea level for a long period of time and became a refuge for many varieties of animals from the neighboring regions after those regions became submerged, which is what occurred on the plains of Middle Asia at the end of the Mesozoic period and during the Pliocene period. Central Asiatic fauna participated in the development of the fauna of the neighboring regions.

The development of Central Asiatic fauna occurs under a continental and dry climate. The consequences are most variegated and lead to very curious ecological phenomena. The presence of a forest belt on many of the desert ranges of Central Asia leads to the intermixing of the highland and desert-steppe fauna. The absence of snow during the winter results in an accumulation of a great amount of ravenous birds that feed on rodents which do not hibernate during the winter.

Central Asia is predominantly a country of hoofed animals and rodents. These animals are most common and, together with the birds, comprise an inseparable part of the Mongolian or Sinkiang landscapes. Antelope are fairly common here; the Mongolian gazelle in the north is replaced by the Middle Asian gazelle in the Gobi; the saiga is found in the depressions of western Mongolia; and the orongo antelope (*Pantholops hodgsoni*) may be encountered in Tibet. The small ada antelope (*Procapra picticauda*) is found in Gobi up to the Tibetan mountains. The following are the only varieties of large animals in Central Asia: the wild yak in Tibet, the two-hump camel in Dzungaria by Lobnor and in the Trans-Altai Gobi (MNR), Przheval'skiy's wild horse in the Dzungarian Gobi but farther to the south of the location of the original species. Drovers of wild horses may still be found at the present time south of the Mongolian Altai between 90°-94°. The onager is still quite common, being widespread in the western part of Gobi. A different species of the onager is encountered in Tibet, Koko Nor, and Nan Shan: the kiang species (*Equus hemionus kiang*). Forest hoofed animals are characteristic only for the western and northern mountain groups which are covered by forests. Siberian taiga elements, for instance, are found at Hentai; such animals as the elk, roe deer, and the Siberian stag (maral) are encountered there. The Siberian stag is found in the Hangai, Altai, T'ien-Shan, and Nan Shan mountains. Wild reindeer inhabit the Siberian border areas, as well as Mongolia and the Sayan mountains. The desert and desert-steppe mountains are inhabited by wild rams (*Ovis ammon*, and in Tibet by the *Ovis nahoor*), as well as by goats (*Capra sibirica*). Rodents are predom-

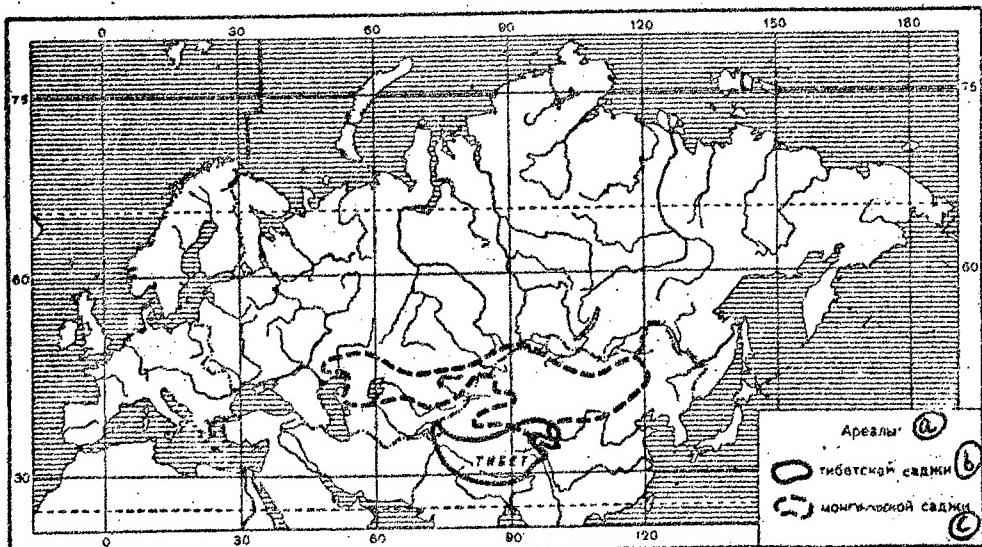
inantly found in the steppes of Mongolia and Dzungaria. Transbaikal marmots are fairly common to the mountain steppes. Also widespread are tree-creepers, little marmots, jerboa, hamsters, rabbits (both Tibetan and tolai), sand-worts, field-mice, and moles. The beaver is found along the Urungu river in Dzungaria and Mongolia.

One of the commonly found predatory animals is the badger which is mostly encountered at high altitudes of the Nan Shan, Mongolian Altai, and T'ien-Shan mountains; however, it does descend to the southern parts of these mountains. The tiger still exists in Dzungaria and the Lop Nor basin. The wolf is found in the plains, while the Red Wolf (*Cuon alpinus*) is found in the mountains. There are also several species of bear: the brown bear in the north (in the Hentai forests and the mountains of Lake Hobsgol), the *Ursus arctos pruinosus* bear found in Tibet, and the large panda bear in the mountains of Eastern Tibet. Also common are the fox, the beech marten (*Martes foina*), the *Mustela sibirica*, the weasel, the lynx, several of the smaller cat varieties, and others. Sable is now quite infrequent in the forests of Northern Mongolia and the Great Khingan.



Distribution  
of the red-legged choughs (*Pyrrhocorax pyrrhocorax*) and  
of the yellow-legged Alpine choughs (*Pyrrhocorax graculus*)  
(According to Ye. V. Kozlova)

Legend: a. Areas; b. Choughs; c. Alpine choughs.



Distribution of the Tibetan and Mongolian sand grouse  
*(Tchangtangia tibetana, Syrrhaptes paradoxus)*  
 (According to Ye.V. Kozlova)

Legend:

a. Areal; b. Tibetan sand grouse; c. Mongolian sand grouse.

The birds are numerous and, in the zoographical sense, belong to the Siberian, Chinese, Mediterranean, and Indian fauna. Certain African species are also encountered (bustards, ryabki\*). The landscape birds are the Mongolian lark (*Melanocorypha mongolica*), numerous chekans\*, the desert jay, as well as the sparrow, are frequently encountered in the deserts. The sound of the kopytka\* or of the sand grouse (*Syrrhaptes paradoxus*), which tends towards dry steppes and does not penetrate deeply into the desert, is unique. The pheasant is found in the bottom lands of the Central Asiatic rivers (Kobdo, Edzin Gol, and Tsaidam rivers). The ulars\* and kekliks\* are quite frequent in the mountains. The desert lakes are inhabited by an abundance of feathered creatures -- a great variety of them have been noted by our travelers. Different species of ducks, geese, pelicans, and cormorants are common to the lakes in the southern part of Mongolia, on the enclosed Gobi water reservoirs, and the lakes of Dzungaria. Beasts of prey are numerous and variegated.

\*Words marked with an asterisk have not been translated, but are transliterated from the Russian.]

Tibetan ornithological fauna includes a number of endemic species, but many such species are much more widespread in the mountains of Central Asia. The mountain or Indian goose (*Eulabeia indica*), the Red duck (*Casarca fer-*

*ruginea*), the Red-legged choughs (*Pyrrhocorax pyrrhocorax*), the Mongolian lark, owls, etc. The Mongolian sand grouse is replaced by the local variety in Tibet (*Tchangtangia tibetana*). The red-neck ground brambling (*Montifringilla ruficallis*) is limited to the Tibetan Uplands; the common crane is replaced by the black-neck variety (*Grus nigricollis*) which is found only in the Tibetan and Nan Shan mountains, and the Altai Hissar bird is replaced by the Tibetan Hissar bird (*Tetroogallus tibetanus*) which also inhabits Nan Shan, Himalayas, and a part of Pamir. According to E. V. Kozlov's estimates, the principal part of the ornithological fauna of the Tibetan highlands is composed of 31 species of nesting birds.

## CENTRAL ASIA PROPER

### Northern Mongolia

The Mongolian People's Republic, with the exclusion of Gobi, is an intermediate transitory strip between the Siberian and Gobi landscapes. Both the Siberian taiga and dry steppe regions may be encountered there. Most of the territory is covered by mountains, which include the Mongolian Note 7 and Gobi Altai as well as the Hangai and Hentei mountains. The principal Mongolian mountain summit is located at the junction of the borders of the USSR, MNR and Sinkiang - and is the Kuytun mountain of the Tabyn-Bogdo-Ola group which is 4,356 meters tall, Ikhe-Bogdo is in the Gobi Altai and is over 4,000 meters tall, the Otgon-Tengri summit in Hangai is 4,031 meters tall and the Asralt bare mountain at Hentei is 2,800 meters in height. The world watershed, which divides the waters between basins of the Arctic Ocean (Irtysh, Ob, Yenisey and Selenge rivers), the Pacific Ocean (Onon, Kerulen and Uldza rivers) and the non-draining basins of Central Asia (Kobdo, Dzabhan, Baidarig, Tes, Tuyn-Gol and other rivers), passes along the crests of the Hangai, Hentai, Tannu-Ola, and Saylyagan mountains and partially along the westernmost sector of the Mongolian Altai.

Note 7 The Mongolian Altai is frequently referred to in literature as Ektag Altai, but it should be correctly read as Aktag Altai, i.e. White Mountain Altai.

The mountains of Mongolia are generally characterized by smooth relief features, wide river valleys, concave slopes, plateau like ridges and flat, rounded summits, which rise beyond the forest line. Along with these characteristic morphological features of the West and North Mongolian mountains, strips of typically Alpine relief are encountered, with narrow gorges, grandiose and steep slopes with boulders and undulating ridges. Such features are peculiar to the Hardyl-Sardyk ridge west of Lake Hobsogol, as well as to certain individual regions of the Mongolian and Gobi Altai. Broad and flat inter-mountain depressions are common to the Mongolian Altai, which frequently contain small lakes at their lowest points.

In addition to the mountains, plains are also noticeable in Northern Mongolia. They are located at a high hypsometric altitude. They are represented by residual outcroppings, leeward ridges as well as "ideal" plains, which are quite widespread in the very west of the MNR, on the border of China and at Barga, i.e. west of the Great

Khingan mountain ridge within the borders of Inner Mongolia. Such "ideal" plains contain enclosed saline depressions, which are typical for the dry Mongolian type steppes located in Eastern Mongolia. The lowest absolute altitude found in the Mongolian People's Republic is recorded at one of these depressions - the perennially dry small Lake Hara-Nur which is situated at an altitude of 532 meters.

A relief and landscape peculiarity is the great depression between Altai and Hangai, which is known as the Depression of the Big Lakes. This name refers to the presence of several large lakes in that region, which include the largest lake in Mongolia - Lake Ubsu-Nur, which is located by the southern foothills of the Tannu-Ola ridge.

Many traces of formerly higher water levels at these lakes, and lake fauna, found among the sandy-clay deposits at the Depression of the Big Lakes, indicate that these lakes were at one time much larger and were possibly merged, forming one or two large basins. At the present time the valleys containing rivers that flow from the east into the Depression of the Big Lakes, include large amounts of sand, which may be regarded as river or delta deposits laid bare by the shrinking of former basins and that brought by the rivers. During the subsequent period these river and lake sands were shifted by the wind in an easterly direction.

Rivers of Northern Mongolia relate to three principal basins: that of the Pacific Ocean, the Arctic Ocean and to the Central Asian basin of non-draining lakes and depressions.

All Mongolian rivers originate high up in the mountains - at glacier edges or in the cold, bare mountains and damp Alpine meadows, where it is moist and swampy. The rivers therefore bear mountainous characteristics, have a fast current, cold water, erode the banks, and deepen the valleys. The Kerulen and Uldza rivers in Eastern Mongolia are the only rivers that are not mountainous at their middle and lower courses. They flow along wide and level valleys between low banks and execute many turns.

As a result of a long and cold winter Mongolian rivers are covered with ice for six months. Some of the shallow rivers freeze to the bottom. One of the interesting peculiarities of Mongolian rivers is the absence of a high water period during the spring. Mountains and plateaus located at an average altitude receive little snow during the winter. Part of the snow evaporates without yielding any moisture. Rains are rare during the spring, and the rivers receive little water from the melting snow. Therefore the rivers raise their levels very slightly and do not overflow. During the summer, however, after the basic high water period passes, the currents flow faster and river depth increases.

During the warm time of the year much snow melts, rains and showers are frequent high in the Altai, Hangai and Hentei mountains, causing rivers of the Selenge basin to overflow their banks and flood the valleys.

All the lakes in Northern Mongolia are divided into two groups: non-draining and draining lakes. The majority of them belong to the first group, such as the Hircis-Nur, Ubsu-Nur, Orog-Nur, Ureg-Nur lakes and others. Lake Hobsogol (Kosogol) in the north, Lake Buir-Nur in the east, Lakes Hara-Us-Nur, Hara-Nur and Achit-Nur in the west are all draining lakes.

Mongolian lakes are also divided into two basic groups according to their position: mountain lakes, steppe and plain lakes. Mountain lakes are mostly flowing, and are therefore fresh water lakes, and they contain clear water, have narrow elongated shapes and are rather deep. Lakes Tolbo-Nur, Kobdo, Tal in the Mongolian Altai, and lake Hobsogol in the north of the MNR fall into that category of lakes. Steppe lakes are situated in flat depressions, they are very shallow, are frequently dry and are often very salty. Some of the larger lakes of this type, such as Lake Buir-Nur, contain water throughout the year.

If particular attention is paid to the distribution of lakes and rivers in Northern Mongolia it is noted that the Hangai-Hentei mountainous region includes the most lakes, i.e. that part of Mongolia which belongs to the Arctic Ocean basin. This basin includes the largest Mongolian river - the Selenge. After flowing for 1,500 kilometers Selenge empties into Lake Baikal in the USSR. The principal source of the Selenge is the Ider river in Hangai. The Selenge is navigable not just within the Soviet Union but in Mongolia as well.

The Shi-Shkhid-Gol river, which is located west of Lake Hobsogol, empties its waters into the Arctic ocean basin through the Yenisey. Hobsogol is the largest lake of the Selenge basin and is the most beautiful one in Mongolia. It is 135 kilometers long and 35 kilometers wide. It is situated between mountains at an altitude of 1,624 meters. The shores of this lake are cleft and form picturesque capes and harbors some of which are covered with trees. The smooth mirror like surface of the lake is broken in places by craggy islands.

The Pacific Ocean basin which is located on the territory of Mongolia is poor in rivers and large lakes. Two large rivers start here and flow partly through that area. They are the Kerulen and Onon rivers. They originate in the high mountains of Hentai and flow towards the east. The Kerulen empties into Lake Dalai-Nur in China which is connected with the Argun river and, consequently, with the Amur river, by means of the so-called Murky Channel, which contains water only during the lake's high water period. The Kerulen is therefore considered to be one of Amur's upper courses, the farthest one from its mouth. Another one of Amur's upper reaches is considered to be the Onon river. The Onon river, in merging with the Ingoda river within the Soviet Union, forms the Shilka river. The Onon valley is one of the most picturesque in Mongolia. This wide valley is surrounded by rounded and steep hills overgrown with a beautiful forest. The valley is covered by meadows of tall grass, dense shrubs and large trees. Onon leaves Mongolia for the

Soviet Union as a full, clear and rapidly flowing river, branching out into several channels. The Uldza river also belongs in the Pacific Ocean basin - it is a shallow river, which is completely dry at its lower course during dry years.

There are many small steppe salt water lakes in the eastern part of the MNR, which frequently dry out. Lake Buir-Nur is the only one distinguished by its large size. It is 610 square kilometers in area. The beautiful Halhin-Gol river empties into it, its sources lie on the western slopes of the Great Khingan. Buir-Nur merges with Lake Dalai-Nur, which was mentioned above, through the Argun river, and that is why both Buir-Nur and Halhin-Gol relate to the Amur basin as well.

Ancient valleys, forming a part of a presently dry, but formerly widespread hydrographic network, are clearly traced among the plains in Eastern Mongolia right up to the Great Khingan. Its dehydration was associated with the change to drier climatic conditions which occurred during the postglacial period.

Rivers flowing off the Altai ridge in Mongolia, which are the south and east Hangai rivers empty their waters into the internal non-draining lakes of Central Asia. Not a single drop of water reaches the World Ocean from there. Some of the biggest rivers of this basin are: the Kobdo, Dzabhan, Tes, Baidarig, Tuin-Gol and Ongin-Gol rivers. The deepest one is the Kobdo river. It gains its waters from the glaciers and snows of the Mongolian Altai. It therefore remains deep even during the driest years. Its high water period begins in May, and during the summer its waters become muddy, and contain much silt, sand and clay. Kobdo empties into the Hara-Us-Nur fresh water lake. Another significant river is the Dzabhan river; it originates in the Hangai mountains and flows into Lake Airag-Nur, which is connected to one of the biggest lakes in Mongolia, Hiris-Nur, by means of a short channel. Hiris-Nur is the final link of a southern group of water reservoirs in the Depression of the Big Lakes and is an enclosed salt water lake with a mineralization level of 9 h/l.

Ubsu-Nur is the biggest lake in Mongolia. It is 3,350 square kilometers in area. It is situated at an altitude of 759 meters. This enclosed lake is located in a broad and deep depression by the border of the Soviet Union. Its salinity exceeds that of the Caspian Sea and equals 18 h/l. The Tes river empties into Ubsu-Nur.

The shores of these lakes are barren and dry.

The Baidarig, Tuin-Gol and Ongin-Gol flow parallel to each other in a southerly direction off the Hangai range. They drain into the enclosed reservoirs in the "Valley of the Lakes". The largest one is Baidarig, which is a rapidly flowing mountain river. It contains clear blue water and at its lower course, ten or twenty kilometers before reaching its mouth, it divides into several channels. Baidarig is an interesting river. In branching out it flows immediately into two lakes. The deepest one of these branches supplies a large Gobi lake called Bon-Tsagan-Nur with its water. The second branch flows towards the east for ten or twenty additional kilometers and finally empties into the bitter-salty Adagin-Tsagan-Nur lake.

Landscapes of Northern Mongolia very strongly resemble both the Siberian forests and, at the same time, the Central Asiatic steppes. Deciduous forests, which are commonly found in Hangai, Hentai and partially in the mountains entering the Altai system, create a peculiar landscape of mountainous forest steppes. Where the forest covers mountain slopes exposed to the north and west, while the steppe terrain is a feature of the opposite sides, the relationship of the steppes to the forest varies according to the latitude. The forests vanish completely in the southern part of Northern Mongolia, and are seen only along rivers deep into the south.

Areas closely resembling the taiga are really quite small, and are encountered in the humid Hentei mountains and mountains around Lake Hubsugul. The forests are composed of Siberian larch, cedar, pine, birch and aspen. The fauna here is predominantly Siberian.

The steppes are grassy, multi-herbaceous and cover large areas south of the preceding landscape and are found particularly in Eastern Mongolia, where they extend from the Trans-Baikal steppes and penetrate towards Gobi. Principal vegetation here is grass, which consists mainly of feather grass, bistort, and koeleria (*Koeleria gracilis*). Fringed sagebrush (*Artemisia frigida*) is quite common. The bush pea tree is a frequently encountered variety of brush; the small leaf variety of this plant (*Caragana microphilia*), which forms low thickets, is mostly found in the steppe regions.

Some writers consider the plains of Eastern Mongolia as the north-eastern extremity of Gobi, which reaches Borzi in Trans-Baikal and Hailar in Barg. Such a concept is wrong. Hydrographically these plains relate not to the Gobi basins of Central Asia, but are drained by the Onon, Kerulen, Halhin-Gol and Argun rivers which empty into the Amur river; they differ from Gobi climatically as well, and the steppe vegetation bears all the characteristics of a region of transition from Siberia to Central Asia and to Gobi.

Gobi landscapes in Northern Mongolia pass along the Depression of the Big lakes to their northermost limit. This depression contains what appears to be a piece of Gobi, except for the fact that it is located at these uncommonly high latitudes. Desert steppes and deserts, due to the relatively low altitude of the depression, the absolute altitude of which fluctuates between 1,200 and 750 meters, extend to the north between the Altai and Hangai mountain ranges, which block the moisture laden air currents and intercept the precipitation. The desert steppes surrounding Lake Ubsu-Nur and Hirgis-Nur must be regarded as the northernmost extension of the dry deserts not only in Central Asia, but in the world in general ( $50.5^{\circ}$  n. lat.).

The above sketch of horizontal zoning is interrupted by a vertical change in the mountain landscapes. In Hentei, for instance, the forests end above 1,900-2,100 meters, and bare areas appear. There is no continuous Alpine belt here, as Hentai is comparatively low and only a few of its summits protrude their

bald, barren and flat summits with thick layers of granite deposits covering the slopes.

The eternal snow belt on the Hangai mountain, which is taller and at the same time drier than Hentai, is quite insignificant in area (is found only at the summit of Otgon-Tengri), the bare strip and rocky deposits are fairly common. A highland tundra, covering the plateau summits, predominates here. Below, this landscape changes into forests, principally deciduous, and into sub-Alpine meadows. The upper limits of the Hangai forests are located at an altitude of approximately 2,500-2,300 meters.

Forests occupy very small areas in the Mongolian Altai, and consist of larch; there are no cedars at all. The forests reach an altitude of 2,400 meters on the slopes of the mountains of the Kobdo river basin. Basic forest massifs cover the southern slopes of the Mongolian Altai in the Irtysh basin. This paradox (in Mongolia, forests are generally found in areas with northern exposures) is explained by the fact that the southern slopes of Altai are external, exposed to the influence of the moist western winds, while the northern slopes at the upper course of the Kobdo river are internal and very dry. Dense forests cover the southern slopes of the Mongolian Altai mountains starting at an altitude of 1,500 to 2,300-2,600 meters of absolute altitude, while the northern slopes are covered starting at 2,100-2,000 meters up to 2,600-2,300 meters (V.V. Sapozhnikov).

The Alpine belt and the sub-Alpine meadows, which come into contact with the dry steppes covering the lower mountain slopes, are well represented in the Altai mountains. Eternal snows cover considerably greater areas of the Mongolian Altai at their western edge, than they do at the Hangai mountains. The present day snow line lies at an altitude of 3,000-3,500 meters. Glaciers are also located there, the lowest extensions of which descend to an altitude of 2,700 meters at the upper course of the Tsagan-Gol river (Potanin's glacier, which is 20 kilometers in length) and even as low as 2,400 meters as in the case of Przheval'skiy Glacier at the upper course of the Kanas river which is a part of the Irtysh system.

The overall area of the glacier-snow field at the Mongolian Altai is 810 square kilometers, according to A. Kh. Ivanov's computations. The largest areas of glaciation are: Munkh-Hairahan-Ula (200 sq. km.), Tabyn-Bogdo-Ula (150 sq. km.), Saksai (125 sq. km.).

#### Gobi (Except Dzungaria)

Gobi is a Mongolian common geographical name, which is used by those people to designate landscapes which consist of either flat desert steppes or semi-deserts, where there are no rivers and where water is found only in wells or springs and where the soil is rocky, clayey, sandy and in spots saline. Gobi, as understood by the Mongols, is an inhabited region; it is not a desert as life and cattle breeding there are possible. The real

desert which is not inhabited by man, is completely devoid of any forage - and the Mongols call it "tsel'". The term "gobi" is therefore frequently encountered on maps as a supplement to a basic name.

Another name for Gobi is Shamo, which in Chinese means "sandy steppe" and is a considerably less accurate description, as sand actually covers relatively small areas.

In the south Gobi rests against the mighty Nan Shan mountain ridges and the H<sup>ang</sup> Ho river; in the north it penetrates into Northern Mongolia, i.e. into Hangai, Altai and the steppes of Eastern Mongolia; in the west it stretches into Dzungaria, and in the east it reaches towards the Yinshan mountains and the southern portion of Great Khingan. Ordos, and the Alashan plains, the landscapes of which relate to Gobi, are in fact a part of Gobi, but in geographical literature are frequently differentiated as separate and independent Gobi regions, which have clearly evident physical-geographic borders; that is why they will be discussed below.

Gobi represents a broad and highly elevated depressed area between great mountain ranges. This plateau, which is traversed by both mountains, having an absolute altitude of up to 3,000 meters and by numerous highlands, in relief is an inseparable part of the Gobi landscape.

Gobi is the largest desert in Asia and one of the largest deserts in the world. The history of its evolution is briefly summarized below. It must be stipulated, however, that much regarding the evolution of Gobi semideserts and deserts is still not clear and mysterious, and only subsequent research and exploration on the spot will be able to shed additional light on unsolved questions regarding the evolution of Gobi's surface.

The Tertiary period was characterized by a dry, but not a desert climate, which was sometimes quite humid. The lake and river network was very well developed and processes of erosion and accumulation were vigorous. Lake and alluvial deposits were formed and were usually represented by lake silt and clay as well as by river shingle and sand. The relief features were of average elevation, the altitudes were comparatively low, as the sediments did not contain large grained matter. Volcanic activity was vigorous and created extensive basalt fields. Gobi was actively eroded.

Towards the end of the Pliocene period disjunctive dislocations were manifest; they rejuvenated the relief and created the contemporary topography, raising the ancient mountain groups of the Mongolian and Gobi Altai. A new relationship between the lake and river basins was created, watersheds were shifted. Erosion increased, the washing away process attained considerable scope as a result of an increase in the difference between relative and absolute altitudes.

Even though the climate must have become somewhat drier as a result of the uplifting movements of the mountain groups along the borders of Gobi, glaciation, which enveloped the principal Gobi

ranges together with its cold temperatures, must have maintained the water level in the lakes together with an energetic fluvial activity, which, in turn, led to an accumulation of sediments in the form of pebbles, frequently filling large cones left by the washing away of sand and lake and glacier silt. Volcanic activity was revived in connection with the vertical movements. Quaternary basalts have been found in the eastern part of Gobi and in Eastern Mongolia. The Mongolian Pleocene may best be studied in the mountains, where traces of glaciation have been preserved (even though not too clearly in the Gobi Altai), deposits of that period, however, are comparatively rare in Gobi.

The postglacial period was characterized by a very arid climate, as a result of which the hydrographic network was either destroyed or became scattered. Many intermountain depressions dried up completely, becoming fully exposed, some lakes remained in others. Traces of a formerly higher water level at many of the lakes found in Gobi depressions are clearly seen; isolation of the lakes, their separation from the rivers, as well as their dehydration and salinization were taking place over an extended period of time.

The role of deflation increased. Alluvial and aeolian deposits were treated by the wind and shifted to the mountain slopes, areas covered with dunes expanded, deflation deepened the uncovered depressions. New masses of sand were formed out of rock. The role of the external aeolian process of removal increased in significance. These processes became dominant and the rate of accumulation of the aeolian deposits, determined on the basis of discoveries of man's artifacts, was very great.

Tectonic movements occurred during the postglacial period as well. They were, however, more of a residual character; they are particularly evident among the foothills where the mountain uplifting movements spread over the adjoining foothill plains. Volcanic activity gradually died down, this process was spreading from west to east.

The present period is distinguished by somewhat higher humidity than that which existed during the preceding period. The sands are secured by vegetation, northern vegetation expands towards the south (the penetration of the forest into the steppe in Northern Mongolia). Fresh river beds are now being cut through prehistoric cones, which were a result of erosion and through the wide, flat meadow valleys. New ravines are being formed. Sand dunes are seen only in regions with high velocity winds or those with exceptionally arid conditions. Gobi at the present time is also characterized by an arid climate; tendencies towards further dehydration, however, are not evident.

Volcanic eruptions in Northern Gobi have ceased completely. The most recent eruption occurred in Manchuria, in the Nonni river basin in 1722. Tectonic disturbances on a small scale are continuing to date. Erosion, however, despite the dry climate, continues to have a pronounced effect. This is partially explained

by the mountainous relief features of this part of Gobi which is within the borders of the Mongolian People's Republic, resulting in rapidly flowing waters, in addition to a large volume of precipitation, scattered vegetation, bare rocks and poorly developed soil on the mountain slopes. Dry river beds cut through mountain ridges to the bottom at the Gobi Altai. The role of the external aeolian erosion has decreased noticeably.

On the whole, Gobi's initial relief, which underwent an extensive period of erosion, in its main features is related to Tectonic type reliefs. Gobi surface features have originated principally through erosion. This was the first cycle in the development of Gobi's surface, and is considered to have occurred during the Tertiary and Pliocene periods. Subsequent leveling was aeolian in nature; this process was particularly vigorous during the postglacial period. Therefore the representation of Gobi's relief as a heterogenous one, created during the prolonged period of continental development of Central Asia, is a correct one.

A relief consisting of leeward ridges composed of fine sand is most common in Gobi. Well differentiated plains are encountered in Gobi, but, as a rule, they do not occupy large areas. Either mountains or hills with gently sloping contours, which upon closer examination turn out to be craggy, full of ravines and gorges, are always seen on the horizon.

Gobi is located at an average altitude of 900-1,200 meters. Desert mountains, with the exception of Gobi Altai, do not bear signs of vertical zoning. Gobi ridges and elevated areas, Hurhu, Hara-Narin and Ihe-Shanghai, are well worn, rocky and barren mountains, with sharply evident signs of desert denudation.

In this area of the Gobi sand covers comparatively small areas. As an example we shall cite some data regarding the Gobi sands, within the borders of the Mongolian People's Republic which contains 61 sandy regions with a combined area of only 10,200 square kilometers. The largest sandy massif is Burid and Argalant, which is located south-east of the Sain-Shand village in the eastern portion of Gobi and covers an area of 1,200 square kilometers. More sand is found at Alashan and Ordos.

There are no constantly flowing rivers in Gobi, except for the upper curve of the Hwang Ho, which left many old river beds that penetrate deep into Gobi and are even now sometimes filled with water, and the Edzin-Gol, which crosses the desert from Nan Shan and almost reaches the southern foothills of the Gobi Altai. Consequently the significance of ground water to agriculture here is very great, since water in this part of the Gobi is available almost exclusively from wells and only infrequently from springs. Wells are rather numerous here, and, most important, as a rule, yield fresh, potable water. The presence of ground water close to the surface at the Gobi depressions considerably facilitates the digging of wells, where water appears at a depth of 0.5-1.5 meters from the surface. In the winter, when the temperatures are

below freezing the small wells freeze as well as some of the underground water springs that supply these wells. When this occurs the Mongolian cattle breeders gather the snow and melt it, or crack the ice in the wells, or migrate to the wells or springs that did not freeze and are usually surrounded by a thin sheet of ice.

In Gobi large areas have no water above the surface. Streams that originate from springs are only infrequently encountered. But such springs completely alter the desert landscape wherever they are found. A green oasis, beckoning to the traveller with its fresh colors, appears alongside the gurgling stream.

There are many lakes in Gobi, most of which are shallow, salty and dry out frequently, exposing a salt covered bed. The largest lakes in Gobi are concentrated in the deep furrow between Hangai and the Gobi Altai, in the so called "Valley of the Lakes"; large bodies of water are found there - Bon-Tsagan-Nur, Orog-Nur, Ulan-Nur and others.

During the Quaternary period bodies of water in the "Valley of the Lakes" occupied an incomparably larger area than they do at the present time. This is substantiated by numerous strand lines indicating a previously higher water levels at the lakes. Lake Orog-Nur is interesting in this respect. It stands out as a narrow glittering strip under the steep northern wall of Ikhe-Bogdo, the tallest summit of the Gobi Altai.

Let us note that the waters of Lake Orog-Nur are mildly mineralized. This is especially peculiar as evaporation, due to the hot and dry summer, is greater here. Some explorers have maintained that the water in the lake is fresh, others talked of salinity. Such diversity in the appraisal of the waters of Orog-Nur is due to the fluctuation of its water level which is sometimes quite considerable. The water is fresh when the lake is filled to a high level.

G. N. Potanin cites a story regarding the drying of Lake Orog-Nur during some years (1893, page 494).

P. K. Kozlov conveys his impressions gained from the observation of this lake as follows: "When looking at Orog-Nur, with its mostly elevated shores, an impression of a deep gap is created, which was formerly apparently filled with water to a much higher level; at the present time, however, according to the Mongols, it is sometimes almost entirely dry; the deepest part is located by the north shore, even though sloughs, according to these same Mongols, are found in many places in this basin. At regular intervals of ten years the small Tuyin-Gol river brings so little water to the lake that it becomes shallow enough for horses and cows to wander about on it; some of the fish gather in the sloughs and some of them perish in the dirt, becoming prey to the winged predators..."

A dune of fine sand has formed on the eastern shore of the Orog-Nur, beyond which larger bank composed of the same type of sand stretches for some distance along the bottom of the valley towards the east and reaches the neighboring smaller lakes. It is

undoubtedly true that within the recent past the deeper part of the valley contained the waters of a single large lake, which by our time only a few small scattered remnants are left." (1947, pp 71-72).

Well differentiated dehydration terraces and surf banks are evident around the Adagin-Tsagan-Nur, Tatsain-Tsagan and Orog-Nur lakes; they are numerous and in places they form a clear cut ladder, which descends to the present shoreline.

The lakes were a typical feature of the Gobi landscapes and the hydrographic network was very well developed during the Early Quaternary period in Mongolia. We have reproduced a sketch of the present and ancient lakes Gahun-Nur and Sogo-Nur, located in the Alashan desert (See drawing on page 47). That sketch quite vividly illustrates the degree of dehydration. G.N. Potanin was the first to observe the fact that the Edzin-Gol lakes had different dimensions in the past. He writes that Gashun-Nur has two old shores on its west side, forming two ledges, the upper one of which is 40 meters above the level of the lake. The terraces contain pebbles and sand; the latter sometimes forms mounds, arranged in parallel even rows. The surface of the upper terrace passes into a pre-lake plain, covered by pebbles (1893, page 470).

The comparatively adequate supply of ground water in the eastern part of Gobi together with the vegetation which covers the leeward, hill covered Gobi plains which are composed of fine sand have led some travellers to observe that this part of Central Asia is not a desert, but rather a region that forms a semidesert and dry steppe landscape.

The gravel frequently scree or slightly sandy surface covering the brown soils supports dry climate gramineous plants, onion, Russian thistle, wormwood without forming continuously covered plots; the background plants of this region are: the small Gobi feather grass (*Stipa gobica*), which forms a sturdy and large sod stratum, the zmeevka (*Diplachne sinensis*), several varieties of wormwood and two varieties of the dry climate tansy (*Tanasetum trifidum*, *T. achiella-ecides*). Very common in Gobi are the short thistle, and the cockspur (*Anabasis brevifolia*), which forms a definitive feature of the landscape, particularly in the south, where thistles are found in greater abundance. The outstanding variety of thistle found on takyr and other compact saline soils is the gemmule bearing thistle (*Salsola gemansens*). Some of the most common varieties of shrubs found on the lower slopes of the mountains are certain types of the pea tree and winterfat (*Eurotia ceratoides*). Among the trees beside the saksaul, the desert elm or the Gobi elm (*Ulmus pumila*), which alone or in clumps grows on the bottom of the Gobi depressions or at temporary water flows, i.e. in places that are close to underground springs, are characteristic for Gobi. Groups of these trees do not form oasis as they do in the Trans-Altai Gobi, since there is no water above the surface of the ground here, nor are

there any little rivers and swamps or green reed or tamarisk thickets. Therefore the desert elm trees, in changing the Gobi scenery, are unable to alter the peculiarities of the landscape of such regions as Gobi.

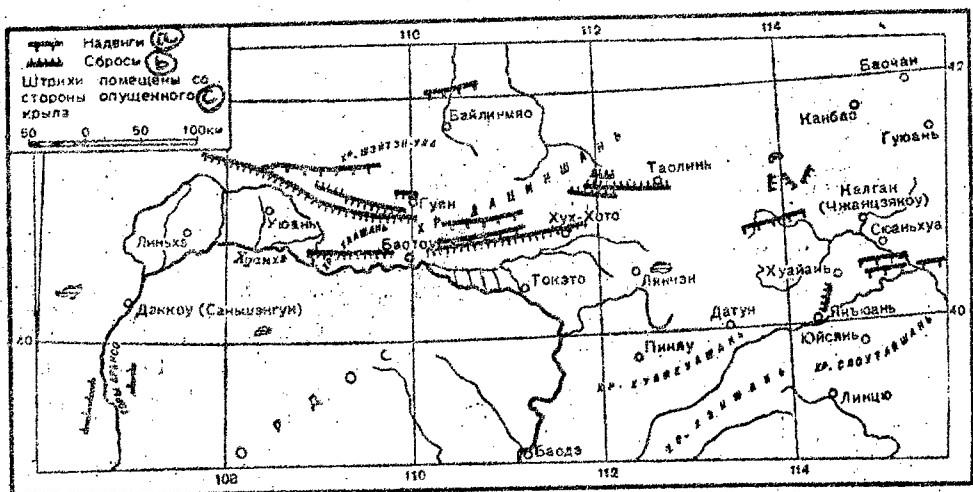
A railroad now connects the city of Kalgan, which is situated at a point where Gobi borders the plains of Eastern China, in the western reaches of the Yin Shan range where it is not a watershed, and the cities of Huh-Hoto (Gui-sui) and Baotou.

The mountains bordering the eastern part of Gobi on the south, are known as the Yin Shan mountains. There are actually three mountain systems here, which are distinguished from each other by both their geological and tectonic structure as well as by their relief features.

V. A. Obruchev points out the western part, or rather, Yin Shan which consists of numerous ranges and occupies an area north of the northern spur of the Hwang Ho. The Hara Narin, Sheiten Ula, Ula Shan, Datsin Shan and ranges connecting with the Mongolian plateau fall into this group, and are situated in a coulisse like row and have an Alpine relief. Their absolute altitudes do not exceed 2,000 meters. Li Ssu-kuang believes that this group of ranges tectonically represent faults and folds which occurred in the direction of the Hwang Ho valley. These lines are clearly traced on the map attached to his work "Geology of China" (1952). Sharp, rocky slopes steeply descending to the south as well as virtually inaccessible summits are shown on that map. This type of relief blends with relatively low gently undulating banks at the Datsinshan range. The central portion of Gobi's mountain border extends to Kalgan. Clear cut ridges are not seen here, individual elevated areas are isolated and appear in the form of flat-topped mountains separated by depressions containing lakes. Basalt effusions which levelled the initial relief features cover the nucleus, which is composed of crystalline rock frequently found on the surface in the form of remnants or in small mounds. Tectonically faults predominate here over folding, but with varying orientations: to the north by Taolin, to the south by Kalgan, to the west by Yungyuan. The 80-90 kilometer wide chain of these table-topped mountains, hills, and knolls extend towards east-south-east from west-south-west. (V. A. Obruchev, 1947, page 326).

The eastern portion of the southern fringe of the Mongolian plateau stretches from Kalgan to the Shentu He and the Hsi Liao He (Shara-Muren) rivers, i.e. up to the Liao Hsi and Great Khingan mountains. The basalt cover over a conglomerate layer, is quite widespread here. This thick layer is easily eroded by water, and the precipitous plateau edge is therefore quite well eroded by the rivers whose sources are located at a higher altitude.

The eastern fringe of Gobi represents a desert and semi-desert type of landscape with some mountain steppes on the slopes with eastern and southeastern exposures.



A tectonic sketch of the Yin Shan mountains (According to Sunyu).

Legend: a. Folds; b. Faults; c. The dashes are on the side of the lowered van.

### ORDOS

The desert country of Ordos lies at the great northern bend of the Hwang Ho river, and is a plateau located at an elevation of over 1,000 meters above sea level. Its landscape represents a direct continuation of the Gobi southward from the Hwang Ho at which point both Gobi and the Hwang Ho cross into the loess plateau of Eastern China.

Despite the proximity of the great Hwang Ho river, which surrounds Ordos on three sides, that country possesses all the characteristics of a desert: the Hwang Ho is here a "foreign" river, which does not irrigate Ordos nor soften its severe winter climate or its hot summers.

The Hwang Ho has a broad and, in part, a low valley among the sand and alluvial desert plains. A phenomena that is quite rare in Ordos may be encountered on the islands located on this river: thickets of green vegetation. The western portion of the Hwang Ho arc is 400 meters wide, but remains unsuitable for navigation. Turning south the Hwang Ho enters a gormose canyon, which cuts through the plateau, however this occurs beyond the borders of Ordos, in the Shansi and Shensi provinces.

Tectonically Ordos is a stable massif - partially belonging to the Chinese plateau. Mountain building processes, so characteristic for Central Asia, left Ordos almost untouched. Along with the Shensi plateau, which continues to the south, Ordos retained its flat terrain features.

A blending of broad elongated gently sloping depressions alternating with low hills and mounds with a relative height of 400 meters comprises the surface features of Ordos.

The Arbiso mountains rise in the west, and stand out with their craggy summits which reach the maximum altitude of 3,015 meters. The Arbiso mountain is a continuation of the Alashan range west of the Hwang Ho river, and is geologically different from Ordos (See Alashan).

Kuzupchi, a sandy desert, is located in the northern part of Ordos. The sand is poorly secured with vegetation. Fine sands, easily shifted by the wind, and formed into dunes and mounds, are common. Mounds of sand are sometimes as high as 50 meters; on the average, however, they are not over 15 meters high.

Bare sand dunes and mounds located south of Kuzupchi alternate with depressions, which are mostly saline lake beds, often dry. V. A. Obruchev observed a widespread distribution of lake deposits in the southern portion of Ordos and along the Hwang Ho valley, which he considers to be somewhat older than the aeolian and river deposits: sand, loess rock, loess, and Hwang Ho alluvium.

The Hwang Ho almost does not drain Ordos at all, which may therefore be classified as an internal basin of Central Asia. This was first done by V. A. Obruchev as a result of his travels in 1892-1894. Only the southwestern portion of Ordos, bordering on Shensi, drains into the Hwang Ho.

The Dabusta lake which receives the waters of several small rivers during the rains stands out among the dry or periodically dry basins.

N. M. Przheval'skiy observed an exceptional phenomena at Ordos on 19 May 1872. On that date he recorded one of the greatest ranges of temperature. From sunrise until one o'clock in the afternoon the temperature rose from  $-2^{\circ}$  to  $32.5^{\circ}$  (a difference of  $34.5^{\circ}$ ).

#### ALASHAN

South of the borders of the Mongolian People's Republic is Alashan -- a barren, very sandy area, containing a mountain range of the same name. The surrounding deserts received their name from that ridge. The Edzin-Gol river crosses the desert from south to north, splitting it; in the southern half are the Peishan mountains and the eastern half contains the Alashan range.

N. M. Przheval'skiy wrote the following regarding the Alashan desert: "The Alashan and other deserts make a depressing, heavy impression on the traveler. He wanders through fine sands or along clay salt flats - day after day and encounters the same scenery, the same ghastliness and desolation....the summer sun is unbearably hot and there is no place to hide from this heat; there is neither a forest nor shade here; a small cloud occasionally appears and shields the

traveler from the broiling sun for a little while. The murky, yellowish-grey atmosphere usually has not a breeze; there are only frequent whirlwinds which lift the hot sand or the salty dust..."

Alashan's surface is homogenous: undulating plains extend from the foothills of the Alashan and the Nan Shan ranges to Galbyn-Gobi in the north. Small groups of hills and knolls appear at rare intervals, and a few small, periodically dry, salty lakes have been observed in the shallow depressions. Dzharatai, one such lake is used as a source of good quality salt.

The Alashan plain on the whole slopes gently from the south to the north, its absolute altitudes vary from 800 and a 1,600 meters. The sand forms true sandy deserts at Alashan; they do not actually form a continuous cover but occasionally alternate with salt marshes, which sometimes contain periodically or completely dry lakes and some bare loess clay deposits. Fine sand forms a knobby, even landscape with relative altitudes of 10-12 meters, rarely as high as 30 meters. Due to the poorly developed vegetation the sand shifts and easily changes the general topographical outline, a meridional direction in the sand ridges is noticeable in the southern portion of Alashan. A veil of fine sand remains in the air long after a storm.

Rivers flowing off the Nan Shan and Alashan ranges disappear upon leaving the mountains, are used for the irrigation of the foot-hill oases and serve as a basic supply of ground water in the desert. Edzin-Gol is the only river that crosses the desert diagonally; that is why its valley is quite densely populated. Ancient caravan routes pass through this valley, with whose aid it is relatively easy to cross the Gobi from south to north.

Edzin-Gol branches out and empties into lakes Gashun-Nur and Sogo-Nur, the first one of which is a salt water lake while the other one contains absolutely fresh water. These lakes are big for Gobi and stand out sharply among the dry deserts. Many visitors note traces of a formerly higher water level at these lakes.

The vegetation of Alashan is principally beach grass; a plant bearing bitter-salty tasting berries which the population uses for food; mongolian dzhuzgun (*Calligonum mongolicum*), the bean-caper (*Zygophyllum xanthoxylon*), which is a plain looking dry shrub; winter-fat and various onions. The sands of the northern portion of the desert contain *Haloxylon ammodendron* and thickets of Bunge pea-trees. According to Przheval'skiy Alashan is *Haloxylon ammodendron* country.

The Russian thistle is very popular among the population both in the sands of Alashan and the sands of northern Gobi, known locally as sulhir, tsulhir (*Agrophyllum gobicum*). It serves as a bread crop for the Mongolians. Its seed is gathered and used as food after frying, or for making flour etc. Beside the sulhir variety, thistle is also commonly found in the lowlands and depression of Alashan.

A mountain range, which along with the Arbiso mountains forms a geologically fresh formation that arose as a result of a disturbance of the plateau regime on the border of the stable Ordos massif, rises

over the southeastern portion of the Alashan desert. The recent origin of the Alashan range is clearly evident in its relief, which is quite different from the Gobi ranges of the Altai, T'ien-Shan and Nan Shan mountain systems. The Alashan range (Chialien Shan in Chinese) stretches in a narrow strip of up to 25 kilometers wide along the left bank of the Hwang Ho. The mountains rise steeply above the surrounding plain; the main summit, Buguta, has an absolute altitude of 3,230 meters, rising 1,500-1,800 meters above the Hwang Ho valley. The range is 270 kilometers long and extends from southwest to northeast; it is generally parallel to the course of the river in this area. Deep valleys and gorges cut through the steep slopes of this range, the upper ridge is not flat, which is a characteristic of many other North Mongolian ranges, but is highly irregular and narrow. There are numerous rock deposits at the higher levels of this range, which disappear towards the middle and lower levels. This phenomena is explained by Przheval'skiy as a result of the fact that the lower half of Alashan is covered with loess dust, which clothes the slopes of this range and masks the basic rock formations.

The lower levels of the Alashan mountains differ little from the landscapes of the surrounding foothill deserts. Both sides of its upper slopes, however, are covered by forests, which were formerly quite dense but most of the trees have by now been felled. The forest serves as a refuge for a typically forest type fauna, which includes the Siberian stag and the musk deer. An Alpine belt is located above the forest. The Alashan range does not reach the level of eternal snows and naturally contains no glaciers.

#### PEISHAN

Peishan [See Note] -- is an intermediate desert highland between Alashan and Kashgaria that links the Nan Shan and the T'ien-Shan mountains; Peishan is orographically directly associated with the latter.

[Note] The largest area of Peishan, its western portion is an administrative part of the Sinkiang province.

Peishan and its surrounding desert (Hami desert), become the southeastern spurs of the T'ien-Shan, on the west, and on the east Peishan is bordered by the Edzin-Gol river valley.

V. M. Sinitsyn believes that Peishan is geologically a formation that differs from both T'ien-Shan and Nan Shan. As these mountain systems since time immemorial have comprised mobile regions. Peishan formerly had a stable regime, peculiar to the Chinese plateau, which was interrupted only by the Alpine orogenesis. Peishan is composed of metamorphic Pre-Cambrian deposits. According to this author the Kuruktagh mountain range forms a part of Peishan. The Alashan range is the eastern extension of the Peishan structures.

The absolute altitudes of these highlands attain 2,791 meters. The surface of Peishan is composed of strongly eroded, predominantly

longitudinal barren ridges, low ranges, and residual high ground areas surrounded by knolls. Mountain summits here have flat tops and rise above the plains rarely higher than 500 meters. Mountain rock is covered by a crust baked on by the desert heat that shines in the sun, which is why Peishan gives an impression of dreariness. The floor of the depressions and dry valleys is covered with an abundance of gravel and pebbles.

Processes and products of wind erosion are exceptionally vivid here. Grotesquely shaped forms, niches, pockets, all create a peculiar landscape, similar to the "aeolian city" in Dzungaria described by V. A. Obruchev. Knolls form a frequently encountered relief feature.

The valleys and gorges of Peishan are dry, there are no perennial rivers or even streams there. The Sulehe, which flows off the Nan Shan does not reach the main portions of Peishan, but turns to the west towards the Lop Nor depression, thereby skirting the southern portion of this region, which adjoins the Nan Shan mountains. Reed thickets and poplars may be seen on the banks of rivers and streams that flow off Nan Shan and then quickly disappear. Peishan proper contains desert and dry vegetation which is found only on the dry valley bottoms and gorges, where some water accumulates during the infrequent rains. G. E. Grumm-Grzhimailo found spruce and birch trees at one location only.

Peishan is bordered both on the south and north by two longitudinal depressions which are quite long. The northern depression extends from Hami to the Edzin-Gol lakes (Gashun-Nur and Sogo-Nur), the southern depression is observed from Lake Halachi, i.e. represents an extension of the Takla-Makan depression.

#### NAN SHAN

A mountainous country to the south of Alashan and Peishan is called Nan Shan i.e. Southern Mountains, which represent the northern mountains to the population of Peishan. Nan Shan is actually a name applying to the northern ranges of that mountain system only, which fringe a strip of oases in the western portion of Kansu. At the present time this name has come to include the entire mountain system, up to Tsaidam and Eastern Tibet. In literature it is still possible to encounter the term: mountains of Kansu, which was coined by N. M. Przheval'skiy; it referred to the eastern portion of Nan Shan only and has now been forgotten.

Nan Shan does not represent a single mountain range. It is a complex mountain system, composed of a number of ranges, which branch out in the west. There are seven such sections there and four principal ones in the east. In the west Nan Shan joins with Altin Tagh which is a conditional term, as Nan Shan is separated from Kunlun by the wide Tsaidam depression.

The direction of the mountain ranges of Nan Shan is not al-

ways uniform, but a clearly predominating northwest to southeast trend is evident, which corresponds to the position of the basic intermountain depressions, that include either river valleys or non-draining and dry lake basins.

The overall length of this system is almost 1,000 kilometers, measured up to the Hwang Ho river, its width is over 300 kilometers.

The following principal mountain ranges which are considered to have the highest elevations stand out in western Nan Shan. The northern range which borders the foothill oases and towers over Alashan, was named the Richthofen range (Chang Chou Shan) by V. A. Obruchev; beyond it are the Ta Lai Shan and Baita Shan ranges, the latter one at its westernmost extension is called Ta Sueh Shan: farther west lies the Zeus range, known by several local names: Yema Shan, Suley Shan, and finally the tall Humboldt, Ritter (Darhandaba) and South Koko Nor ranges. The last three ranges were named by N. M. Przheval'skiy. The South KoKo Nor range in the west is connected to the Mushketov range.

In the east direct continuation of the Richthofen range is the Momo Shan; beyond are the North-and South-Tetung (Tatung) ranges from Ta Lai Shan and Zeuss, and finally, the South-Koko Nor range extends to the east as the Ama-Surgu range.

On the basis of material gathered in the course of his travels, V.A. Obruchev divides all of Nan Shan into three parts, which have different landscapes: the western, middle and the eastern parts.

The western part, which is the highest one, is a desert. Mountains in the Humboldt range rise to an altitude of 6,346 meters, most of the passes are above 3,600 meters. Glaciers and extensive snow fields are found in this part. The altitude of the snow line fluctuates between 4,600 and 5,200 meters here.

The characteristic morphological features of the western part of Nan Shan are an undivided relief and a considerable accumulation of loose matter in the vicinity of the ranges, as it is not entirely removed by the flowing waters. The ranges here are massive and rise in steep, short slopes above the valleys.

Western Nan Shan receives little precipitation, and is therefore dry and rocky; the soils are gravelly and the vegetation meager, principally consisting of small thistle shrubs. The wide depressions located between the mountains have elevated, dry and barren plateau-like surfaces. Despite the large amount of firn and ice, few rivers originate within western Nan Shan; surface evaporation here is considerable. Most of the forests which come from the snow-glacier belt disappear by the middle or lower areas of the mountain gorges, where the water flows rather energetically, as a result of which a colossal mass of matter washed away by the water accumulates in the foothills.

A specific feature of the orohydrography of Nan Shan is the fact that not one of its ranges is a watershed, they are all traversed by narrow, wild gorges, which contain the very fast flowing

waters of generally shallow rivers of western Nan Shan that are part of the local basins: Edzin Gol, Sulehe, Buhyn Gol and a few others.

Middle Nan Shan is intermediate part, and has a mountain-steppe type of landscape; some small forests and thickets are encountered here; forests growing on the northern slope of the south Koko Nor range are found in the west of Middle Nan Shan, where juniper and T'ien-Shan fir form isolated forest island, which stretches from Lake Korlyk-Nur and ends a considerable distance before reaching Koko Nor. This strip continues to the east and turns into bushes and dense grass.

In Middle Nan Shan meadows rise up to the rocky summits along damp slopes. Even here the relatively low and wide valleys between the mountains have a desert scenery, and it is not without reason that the local Mongols frequently refer to them as gobi, thereby stressing their lack of water and desert-like landscape.

The lower eastern part of Nan Shan differs sharply from the western part. Eastern ranges intercept the residual moisture borne by the Chinese monsoon, that is why summer rains are quite frequent here. Eastern Nan Shan contains quite different landscapes. Even N. M. Przheval'skiy, in his account of the third trip to Central Asia, in comparing Western Nan Shan with its eastern part wrote: "In general there is much resemblance between Eastern Nan Shan and the neighboring mountains of west China, whereas Sacheysskiy (i.e. western - E. M.) Nan Shan like Alashan, represents a range of a Central Asian desert."

Landscapes of Eastern Nan Shan are not Central Asian. There is much less eternal snow there; it is a characteristic of only a few tall mountain summits (over 5,000 meters), but does not form a continuous belt. The Alpine strip, how ever, with a variegated brightly blooming mountain valley vegetation occupies a considerable area there. Dense forests, principally coniferous, form a vividly distinguishing feature of eastern Nan Shan; even here the exposure of the mountain slope plays a great role. The forests obviously thrive on the northern slopes.

While in western Nan Shan loess was not an important part of the landscape, here it covers the slopes of the mountain ranges with a thick layer, softens the relief features and is conducive to the development of a luxuriant vegetation.

Many rivers of various sizes are found in Western Nan Shan, and no valley, gorge or ravine are ever dry. Therefore the rate of mountain erosion here is more pronounced, the gorges are deeply etched into the slopes and the hydrographic network is widespread. The wide valleys between the mountains frequently contain marshes, small mounds and puddles of water.

Western Nan Shan in the most part and in a hydrographical sense belongs to Central Asia. Its rivers, the Tetung, Hsin In He and Chagan relate to the Hwang Ho basin.

Koko Nor, the biggest lake in Central Asia which has attracted the attention of many travelers, is located in the Nan Shan mountains. [See Note7]. It is 100 by 64 kilometers in size, and is located at an absolute altitude of 3,205 meters, that is why Przheval'skiy classified it as a high mountain Alpine lake. The deepest part of this lake found up to that time, according to soundings made by that traveler, was 18 meters and was recorded at a distance of 18 kilometers from the southern shore of the lake. A. A. Chernov was successful in recording a depth of 37.5 meters between the Kuisyu island and shore, it must therefore be assumed that the deepest points have not yet been found.

[Note7] Mongolian name -- Blue Lake; Chinese -- Tsinghai, meaning the same; Tibetan -- Sokpo Tsononnan -- Mongolian Blue Lake.

As an enclosed lake Koko Nor contains mineralized water (dry residue of 11 grammes per litre), cooking salt is found among the salts existing there. The lake basin is very small by comparison with the size of the lake, which is a characteristic of an inclosed mountain lake; it is fed by Buhyn-Gol river, which originates in southwestern Nan Shan, and by seven other short and shallow rivers. The level of this lake fluctuates considerably depending upon the climatic conditions. There are five islands on the surface of this lake, one of which (the central one) contains a buddhist monastery. Three islands are composed of sand and are close to the lowland eastern shores. Koko Nor freezes during November. Towards the end of the winter the ice becomes 2 meters thick; the ice breaks up by the end of April. In 1873 Przheval'skiy observed how the ice began breaking up on 6 April (by the new calendar), the lake was free of ice by the middle of April; in 1884 the first ice movements were recorded by him on 13 April; it must be supposed that the lake became entirely free of ice during the last ten days of April. 1873 had an early spring which is why the date of the ice movement may not be considered typical for a lake at so high an altitude.

The shores of Koko Nor are generally low, sandy and in spots, marshy. Hara-Nur, a small salt lake, which was once a part of the main lake but became separated as a result of the drop in Koko Nor's water level lies in direct proximity to the northwestern shore. This is substantiated by the lake deposits, which rise for tens of meters above the present water level. Occasional references to former drainage by this lake into the Hsin'li He river, through the Aragol bed, may be found in literature.

The lake is rich in fish, which causes a great number of birds to migrate there during the summer. The variety of fish however, is negligible.

The areas around the lake are barren and covered with dry steppes. Accumulations of sand along its eastern shore form hills 50-100 meters high. Feather grass, buffalo pen (*Thermopsis lanata*) and chiy are commonly found along the shore, while wormwood, oriental climatis and crazy week (*Oxytropis*) grow in the sand,

spruce and Przheval'skiy poplar are the most frequently encountered trees, which here develop to the size of a bush, (Przheval'skiy's third trip, SPB, 1883, Moscow, 1948). The Tibetans and Mongols graze herds of domestic animals in the depression occupied by the lake.

#### THE DZUNGARIAN MOUNTAIN REGION

In a geographical sense the Sinkiang province is sharply divided into two large and isolated physical-geographic regions: the Northern part or Dzungaria and the Southern part or Kashgaria. Kashgaria is frequently referred to in literature as Eastern Turkestan, as contrasted with Soviet Middle Asia, which was called "Russian Turkestan" in the old literature.

Dzungaria and Kashgaria are two large Central Asian depressions, which are divided by the great wall of Eastern T'ien-Shan. Orographically both of them have much in common. Dzungaria is bordered on the north by the snow capped mountains of the Mongolian Altai and Kashgaria is enclosed from the south by the tallest mountain structures of Kunlun and Altintagh. Both depressions are open to the east, where they merge with the desert expanses of the Gobi. The surface inclinations of Dzungaria and Kashgaria are in opposite directions. In Dzungaria the terrain descends to the west, where by Lake Ebi Nur the absolute altitude is only 190 meters, in Kashgaria the gradient drops from west to east, where the level of Lake Lobnor lies at an altitude of 780 meters.

Dzungaria still manifests concrete differences in a geographical-physical respect from the neighboring Kashgaria. The latter is situated farther to the south, and is more isolated by mountains, being completely shielded by them from the west, which is an important consideration for the understanding of Kashgaria's dry climate. Therefore the extent of the desert terrain, lack of precipitation and vegetation, dimensions of the sandy accumulations are all manifested to a much greater degree in Kashgaria than on the northern side of the T'ien-Shan. This is substantiated by the corresponding relationship in the number of different varieties of vegetation, which is encountered on both sides of Eastern T'ien-Shan. According to data compiled by M. G. Popov, there are up to 500 different varieties of flora in Kashgaria, whereas in Dzungaria this number increases to 2,000. The dividing line between the floras of these two depressions is very clear and passes through the T'ien-Shan mountains.

On the north Dzungaria is bordered by the Mongolian Altai, and in its southern slopes covered with forests is the source of the Black Irtysh, the only river in Dzungaria and all of Sinkiang that drains into the ocean. The short but high Saur range (3,846 meters) See Note 7 lies in the west of Dzungaria and borders on the USSR. Saur extends in a direction characteristic for the Mongolian

Altai and similar to that of the neighboring Tarbagatai range, it also bears certain geomorphological strains peculiar to the Mongolian Altai. The summits of the Saur range are tall even plateaus covered by knolls and mounds. Its slopes are steep and abrupt, etched with gorges. The Saur range contains eternal snows and glaciers at the Mustau junction. The glaciated area is approximately equally divided between the Soviet and the Sinkiang parts of the range (a total of only 12.5 square kilometers). Some deciduous forests are found on the slopes of the Saur, and its lower parts are covered with steppes. The Saur range descends towards Lake Uliungor in a number of comparatively low and dry strata.

Note Maps of the 1954 edition of the World Atlas show an altitude of 3,085 meters.

Landscapes of the neighboring Tarbagatai are similar to those of Saur, but are somewhat lower. Tarbagatai contains no snow and has no glaciers, even though traces of ancient glaciation are clearly evident there. Forests in Tarbagatai are found in the valleys, where they are accompanied by rivers. According to V. A. Obruchev, Tarbagatai is a group elevation with a short and steep southern slope that descends to the plains of Lake Ala kol.

Tarbagatai ends at the Semistai range (2,621 meters) upon descending to the east and at the wide Urkashar range (2,530 meters), which extends to the southwest.

Barlyk is the next border range to the south. Some writers ascribe it to the T'ien-Shan mountain system, which is disputable. Barlyk has an eastern mountain chain which also extends from the northeast to the southwest and is called the Dzhair and Mayli (2,550 meters). These mountains in general preserve their table-topped surface, forming frequent and wide saddle shaped inversions, and from a distance it therefore appears that these ranges have ridges with a broken and a jagged outline. Ancient glaciation had a profound morphological effect on the Barlyk range.

Barlyk reaches an altitude of 2,923 meters and has no eternal snows nor glaciers, its upper levels have rocky deposits, below which is the Alpine belt extends into the mountain steppes. The forest occupies a small area at the center of the elevation, where fir is found.

The border mountains cited above were originally high mountain plateaus that have by the present time become extensively demolished, eroded and transformed into mountain ranges. That is why table-topped mountains are evident throughout this region, as well as the terraced mountain slopes, which descend in steps to the surrounding plains. Denudation had the greatest effect on the lower terrace, the surface of which is covered by quicksand and a wind-blown knoll relief. The so-called Dzungarian or Ebi Nur gate extends between Barlyk and the Dzungarian Altai, and represents a low and desertlike pass between the mountains, which connects Lake Ala kol depression in Kazakhstan with Ebi Nur in Dzungaria, i.e. the

Dzungarian Gobi with the Balhash basin. Absolute altitudes of some of the elevated passes are as high as 400-450 meters. Tectonically the Dzungarian gates form a flexure between two protruding ranges.

The Dzungarian gate is 100 kilometers long and 10 to 40 kilometers wide. It performed a most significant role in the history of the Asiatic peoples, as it represents the pass that attracted the nomad hordes in the course of their invasion of the west. This same pass was used by the migrating Dzungarian tribes that were crowded out by the peoples from the East, Mongolia and China. An imposing snowcapped and wooded mountain range of the Dzungarian Altai with vivid traces of ancient glaciation, towers over the Dzungarian gate.

#### EASTERN T'IEN-SHAN

T'ien-Shan, which is situated within Sinkiang, is called Eastern or Chinese T'ien-Shan, and is known under various local names at the different regions: Halyktau, Kokteketau, Bogdo-Ula, Karlyktagh /See Note 7 etc. Eastern T'ien-Shan extends from the HanTengri juncture (6,995 meters) from west to east in an almost exclusively longitudinal direction within the borders of Sinkiang for a distance of 1,200 kilometers, where it ends with the eternally snow covered Karlyktagh group (4,925 meters). Beyond that point T'ien-Shan continues through the Mongolian People's Republic in the form of individual scattered ranges and mountains: Tumurtu, Tsagan-Bogdo-Ula, Chingis-Tau and others, which are situated among the deserts of the Trans Altai Gobi, forming what appears to be separate links heading towards the Yin Shan.

T'ien-Shan is composed of Pre-Cambrian Paleozoic deposits, more recent scattered deposits are found in the intermountain depressions. Meso-Cainozoic deposits of Eastern T'ien-Shan were studied by N. A. Belyavskiy, who points out various continental deposits dating from the Triassic to the Pliocene periods. Their lithological composition is as follows: sandstone, conglomerates, shale, clay and other matter. Judging by the small strata of compact limestone it would appear that during the Upper-Tertiary period the southern slope of T'ien-Shan was submerged under a narrow elongated bay that was enclosed by the western portion of the Chinese T'ien-Shan. This bay was connected with the Alay strait by the sea which covered the eastern part of Soviet Asia (DAN, 1948, vol 61, extract 1).

The morphology of Western T'ien-Shan, which is characteristic of this range in its main features occurred in the Mesozoic period, the present day relief, however, is the result of a young mountain building cycle, that radically changed the hypsometric level and the surface features of many mountain structures in Asia.

The ranges of the Chinese T'ien-Shan are the result of up-lifting and the intermountain depressions are flexures, where the

by-products of erosion accumulate. The tectonic relief was significantly altered by erosion, which is especially evident in the west. Along with the tectonic valleys Eastern T'ien-Shan has a number of river valleys that are typical products of erosion, the dismemberment of the tectonic relief in places has completely altered the ancient relief features (Halyktau and Kokshal-Tau ranges and others). Of great significance is the effect of wind erosion and deposits, which raise the level of the intermountain depressions and bury their initial relief features.

Eastern T'ien-Shan is 300 kilometers wide. These 300 kilometers serve as the dividing line between Dzungaria and Kashgaria. The main range is a clear geographic and administrative border between these two basins. On the northern side the mountain waters of T'ien-Shan flow down into the lake basin, i.e. Balkhash, Ebi-Nur and Airan. In the south the mountain waters of T'ien-Shan gather into the left tributaries of the Tarim river. Eastern T'ien-Shan attains its greatest height in the Bogdo-Ula mountains - 5,445 meters and in the Halyktau range - 6,811.

A peculiarity of Eastern T'ien-Shan is the existence of a coulisso like structure of the mountain ranges, wide and long valleys between the mountains and deep depressions, which are found at various hypsometric levels, such as Bagashkul, for instance (its water level is at an altitude of 1,030 meters); other ranges bear traces of former basins, presently lowered and transformed into river valleys, and also of completely enclosed basins containing dry or periodically dry salt flats. An example of the latter is the pre-T'ien-Shan depression with the remarkable Turfan or Lukchung hollow the bottom of which is occupied by the bitter-salty lake Bodzhanta, with an absolute altitude of minun 154 meters. The lake is circled by deposits of cooking salt and gypsum, and on the east it is faced with quicksand. We are here, therefore, dealing with the deepest depression in the world, which was first discovered by the G. E. Grumm-Grzhimailo expedition in 1889. The absolute altitude of this depression was first determined at -130 meters in 1893-1894 by an expedition led by V. I. Roborovskiy.

The northern slope of T'ien-Shan steeply descends to the plains of Dzungaria; this slope is short and is covered with deep and steep gorges.

Eastern T'ien-Shan contains numerous glaciers. East of Han Tengri in the Halyktau range there are over 100 glaciers, the largest of which is Karakorum, which is 40 kilometers long. Approximately 50 glaciers are located in the Borohoro mountains at the river which flows down into Dzungaria (Kuytun, Manass and other rivers), as well as in the Bogdo-Ula mountains where some of them are up 12 kilometers in length, as well as in other parts of Eastern T'ien-Shan.

The altitude of the glacier firn-line limit fluctuates between 2,750 up to 3,500 meters, and the altitude of the snow line at Bogdo Ula and Kucheng is 3,690 meters (northern slope).

Coniferous forests cover the slopes of the mountains up to an altitude of 2,900 meters starting from 1,700 meters (according to observations made by M. V. Pevtsov at the Bogdo-Ula range), the lower rows of trees consists of Siberian larch (*Larix sibirica*), beyond which the Schrenk spruce (*Picea schrenkiana*) is found. In the Tihua Urumchi mountain region the forest occupies altitudes of 1,500-2,000 meters (M. G. Popov).

A number of oases are found at the northern foothills of the mountains irrigated by waters of the numerous lakes appearing from the depths of T'ien-Shan, that are almost immediately used up in the irrigation of the agricultural plots (except the western part).

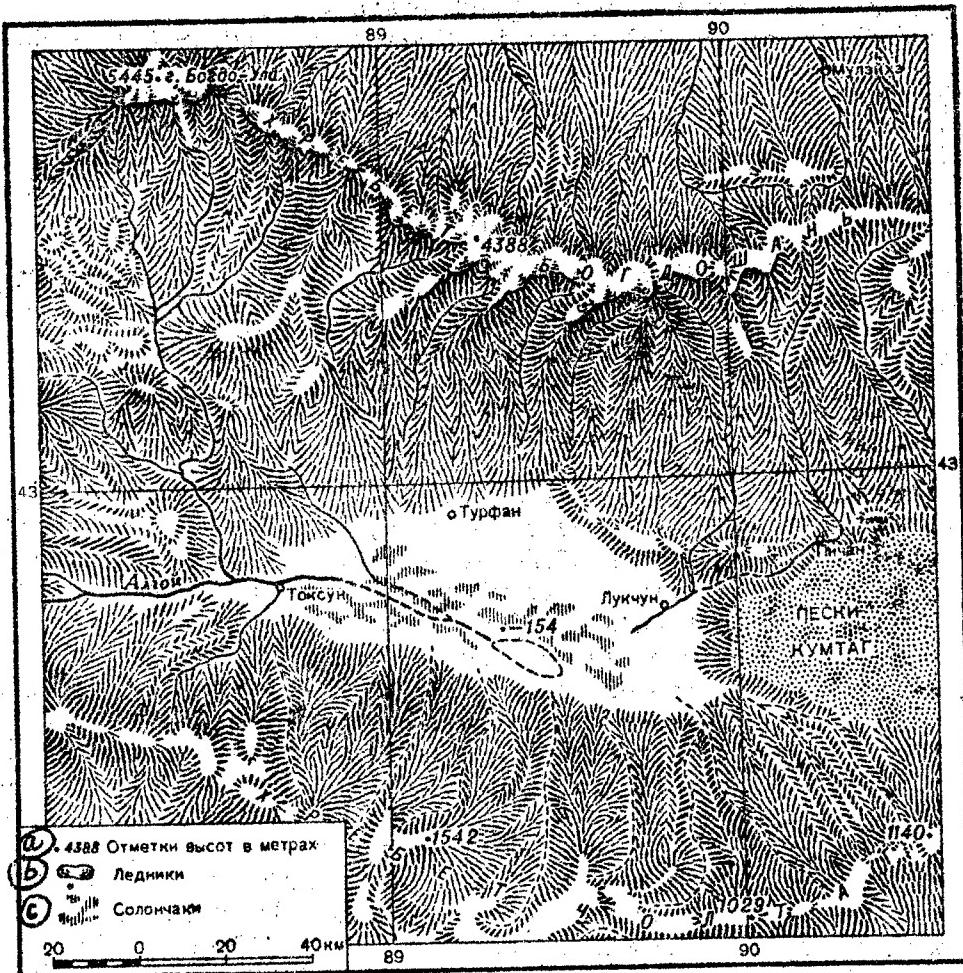
These oases contain almost all of the cities of Dzungaria: the capital of Sinkiang, Urumchi, as well as Kuldja, Manass and Chenhsia (Barköl).

The southern slopes of Eastern T'ien-Shan are not as clearly expressed in the relief as are the northern slopes. They are diffused, longer and are interrupted by intermountain depressions and hollows. The southern slopes are poorly wooded, waterless ravines and gorges are frequently found, the rocks are often uncovered. The forest is encountered only in the upper parts of the southern slopes of the main range. Desert landscapes are common to the lower slopes of the mountains and at locations without oases where dry, stony and infertile soils predominate. It is a curious fact that, in connection with the above, underground water reservoirs are found by the foothills of the southern slope, of the type encountered in some of the exceptionally dry areas of Iran, Turkey and in our own country in the Turkmen Republic by the foothills of Kopet-Daga.

A number of large oases are located at the southern slopes of Eastern T'ien-Shan: Hami, Turfan, Karashar, Kuche, Aksu and others.

Eastern T'ien-Shan extends in several spurs to the south, the principal one of which is Choltagh. Its name means "Desert range" and is descriptive of the predominate landscape there. The degree of bareness increases towards the east. The neighboring Kuruktagh (Dry range) is geologically related to Peishan. The western portions of these ranges are also known under other names (Bortoula, Argyy, Bugur, etc.), at the mountain junctions the branches are tall and covered with snow, the natural environment differs little from that at the main T'ien-Shan. The Kuruktagh range in the central portion is 2,700-2,800 meters tall, towards the east it becomes considerably lower, merging with the hilly and sandy relief west of Peishan.

The significance of Eastern T'ien-Shan as a physical-geographic border between Dzungaria and Kashgaria was underlined above. It has exceptionally great role in the country's economy. T'ien-Shan receives a considerably greater amount of precipitation than the neighboring regions with desert climates, due to its great height. Rivers that irrigate oases in the foothill strip of Dzungaria and Kashgaria originate on T'ien-Shan. It is possible to state, without exaggeration, that the agricultural economy of Sinkiang is to a great degree dependent especially on the waters of Eastern T'ien-Shan.



The Turfan (Lukchung) hollow.

Legend: a. Altitude in meters; b. Glaciers; c. Saline soil.

Over half of the population in this province is concentrated in the cases that are located by both slopes of Eastern T'ien-Shan. The spacious longitudinal faulted valleys and depressions lend themselves for use as grazing land and for cultivation. The Ili river valley in Sinkiang is well known (Kuldzhin region), which is located at altitudes varying from 670 to 800 meters, is well known. [See Note]. This broad steppe valley is etched with irrigation canals that supply water to both field crops and extensive orchards which are fringed with rows of poplar trees. Dry steppe appears higher along the valley, where the crop landscape disappears, and the river is followed by bottom land forests (poplars, apple trees, willows, etc.).

Note The Ili valley continues to the west within the borders of Soviet Kazakhstan (Lake Balhash basin).

Not a single foothill oasis in Sinkiang may compete in economic significance with the Kuldzhin region.

The valleys of the Great and Small Yulduz, which were formerly ancient lakes judging by the terraced landscape, are a type of high mountain Alpine longitudinal valley found in Eastern T'ien-Shan. The absolute altitude of these valleys is 2,400-2,700 meters. During the summer the large grazing lands of the Yulduz overgrown with dense grass, become covered with the yorts of the nomad cattle breeders, who regularly drive their cattle to this area. During the winter this area is uninhabited. Deep snow covers the wide and flat valley bottoms.

#### DZUNGARIA

The Dzungarian or Trans-Altai Gobi, which is enclosed between the mountain systems described above, occupies a depression located at absolute altitudes of 200-1,300 meters, with individual barren ranges and elevations that rise above 2,000 meters. This part of Gobi is the western spur of a great Central Asian desert and in its western portion represents a somber and desolate desert. Valleys are the predominant surface characteristic here, among which low mountains, hills, knolls and quicksand are common. Plains with an undulating relief together with sandy or gravel deposits are frequently found here, which cover extensive areas in the central portions of Dzungaria. The greatest accumulations of sand are found in the central strip of Dzungaria from the Urungo river in the north to the foothill gravel plains of Eastern T'ien-Shan. These sands Dzosotyn-Elisun cover an area which almost 160 kilometers wide represent a dune and mound-hollow relief. In the west of Dzungaria and along the strip closest to T'ien-Shan or Mongolian Altai, the sand regions are interspersed with salt flats and takyr. Closer to the mountains systems, that surround Dzungaria, the plains are replaced by the hilly terrain of the foothill area, which gradually rises towards the mountains.

The eastern portion of the Dzungarian Gobi is most peculiar in the morphological sense. The Altai systems gradually converge here as well as the Dzungarian ranges of T'ien-Shan, that is why mountain ranges rise in the middle of the desert, and, like the Altai, extend to the southeast and also like the T'ien-Shan, longitudinally. The desert mountains here attain an altitude of 2,702 meters at the Atas Ula mountain and the depressions drop to 700 meters (Narinhuu-Gobi). Hilly plains are also quite common here as well as typical knolls. A characteristic feature of the relief are pedestals, tilted plains surrounding the mountain structures. They are common to the Gobi mountains and ranges, but are especially well developed south of the Mongolian Altai, where they frequently bury

half the high mountain ranges and sometimes cover the entire mountain, and the presence of mountains is evident only by short protruding jagged summits.

An important role in the orography of Trans-Altai Gobi is performed by dry water beds (sair, in Mongolian). It must be stressed that activity of flowing waters despite the total absence of perennial rivers and the very low level of precipitation, is one of the most important geomorphological factors here. The explanation of this paradox is as follows. The great variation in altitudes is conducive to an energetic process of water erosion, which is also aided by the presence of a type of ground that is easily eroded by water and which also has poor filtration capabilities. To this must be added the extensive amount of bare rock and metamorphised slate, which basically compose the mountains, the torrential nature of the precipitation and a very poorly developed vegetation. It is therefore evident that the rare showers create temporary but powerful torrents of water which vigorously erode the surface of the Trans-Altai Gobi.

The dry hydrographic network is very extensive here, some individual beds cut through elevations and even ranges, draining the intermountain depressions on both sides of the mountains. These beds are basically inclined towards the south, in the direction of the pre-Altai depression, which is there covered principally with takyr soil, sandy areas and salt flats.

The Dzungarian Gobi is irrigated very poorly. The perennially flowing water is found only in the western region of Dzungaria. The Black Irtysh and Urungo rivers flow through the northwest, where the desert is replaced by the steppes. Urungo is the last river of the southern slope of the Mongolian Altai, whose water does not disappear after it leaves the mountains, but flows for 450 kilometers towards the west and reaches the non-draining basin of Lake Uliungor. This non-draining, slightly alkali Dzungarian lake is noted for the fact that its shores are situated some 3 kilometers from the Black Irtysh river, which at the present time has no connection with the lake. This undoubtedly indicates that the river and the lake both were part of a single system, which is further substantiated by the low mineral content of the water at Lake Urungor. Such an association between Irtysh and the lake is further certified by V. V. Sapozhnikov. At the present time the level of Irtysh is 5 meters above that of the lake.

Rivers flowing into the Ebi-Nur and Telli-Nur lakes (Kuytun, Manass and other small rivers), pass through western Dzungaria.

The steppe landscapes of the border areas of Dzungaria, that are adjacent to Altai, Saur, Tarbagatai and T'ien-Shan abruptly change into semideserts and deserts. The steppes on the northern slope of T'ien-Shan are mainly covered by sheep's fescue and feather grass, which is joined by wormwood and the pea-tree in the dry places. A peculiar landscape here is created by the desert elms

(short) which grow in groups or singly. Gypseous gravel desert that is mostly situated by the slopes of T'ien-Shan contains predominantly thistles, the principal variety being cockspur (tar, in mongolian). The Trans-Altai desert south of the Mongolian Altai is between 96°- 98° meridians striking in its somberness. While in the center of Dzungaria various types of vegetation are common the tens of kilometers of desert at its eastern edge are covered with infertile clayey soils, covered with black sun-baked gravel and pebbles. The white bones of dead camels lie by the barely discernible path, which is traversed by an infrequent caravan. It is only in the small lower portions of the relief that widely scattered knolls with the more hardy type of joint fir - Przheval'skiy fir, are seen. The intermountain depressions, and the slopes of the desert mountains, where vertical zoning is almost imperceptible, are predominately covered by scrub and bush type of desert.

The oases, that are found along the infrequent underground streams and in depressions with water directly below the surface of the ground, present a sharp contrast with the dry deserts with widely scattered vegetation. Tall weeds grow in dense thickets at such oases, which are surrounded by extensive dry salt flats. Such areas are commonly planted with poplar (*Populus diversifolia*), which extends to the east up to 100° E. lat., elaeagnus (*Elaeagnus augustifolia*) is also encountered, as well as willows and tamarisk. The Ehin-Gol, Shara-Hulsu-Ni-Bulak, Tsagan-Burgasny-Bulak oases at the southwestern end of the Mongolian People's Republic are of this type.

Dzungarian Gobi is the site of some of the rarest animals in Central Asia. The wild camel is found in this area; Przheval'skiy's wild horse inhabits this region, it is found in an area that encompasses the desert hills of Tahinshar, that are located south of the Mongolian Altai, along the Sinkiang and Mongolian border. Tahinshara-Nuru, in translation means - the range of wild yellow horses. The rare Gobi bear is encountered in the desert plateau of Tsagan-Bogdo in the Trans-Altai Gobi; it inhabits a very small region that is enclosed by this and the neighboring elevations. The onager and the Middle Asian gazelle are quite numerous here; they prefer the open expanse of the desert in Dzungaria and the Trans-Altai part of Mongolia. The thickets of the Manass river are inhabited by the tiger, which is now rarely found in the valleys of Kashgaria.

#### KASHGARIA

Kashgaria is the other great Sinkiang depression. It is more isolated by the mountains than Dzungaria, a geographicl comparison with which was made above.

Kashgaria or the Tarim depression is the greatest non-draining basin in Central Asia; it is 1,300 kilometers long and 520 kilometers

wide from north to south at its widest point; it covers an area of 400 thousand square kilometers.

The paleontology of the Quaternary period of the Kashgarian depression, the history of the development of its relief has been brought to light during the recent years due to the research accomplished by V. M. Sinitsyn. [See Note 7]. The early stage of the Quaternary period (Pleistocene) was characterized by conditions analogous to those of the Tertiary period. The Kuchar depression was developing during the Pleistocene period in the north of Kashgara, and the Yarkand depression was developing in the southwest. Most of the area was covered by a sloping intra platform elevation, which Sinitsyn called the Oikhar, at that time there was no single basin.

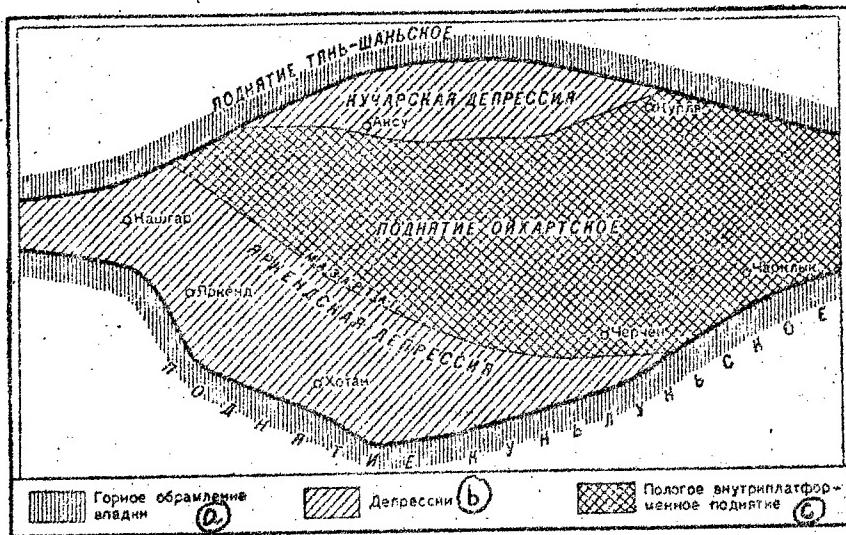
Pleistocene deposits of the depressions are found in the following order from the mountains towards the center: conglomerates, sandstone, clay, the clay deposits originated from lakes. The climate at that time was somewhat more humid than it is now.

At the end of Pleistocene period Kashgaria underwent mountain building movements. This young Alpine cycle created a number of mountain ridges and banks generally situated towards the peripheral part, in the interior region of Kashgaria, where no tectonic effects were felt and conditions remained as before.

The Quaternary deposits in Kashgaria consist of aeolian and alluvial gravel in the foothill areas and the strip immediately around the mountain. The sand and clay of the southwestern portion of the Tarim depression which originated from lakes contain fresh water fauna; the lakes were located between Mazartagh and the Knotai oasis.

The thin layers of lake clay and the fine sand of the interior parts of the Tarim depression are generally found in layers 6 meters deep; in the valleys they are replaced by river deposits, aqueoglacial sediments of the terrace, the upper belt of which penetrates to the bottom of the torg. Therefore Sinitsyn considers that the lake sediments of the Tarim depression and those of the lake period are both associated with the time of glaciation. This pre Kunlun lake basin was not the only one; there was another large lake basin where the Lop Nor hollows ended. A process of loess accumulation was taking place at the bottom of the Tarim basin as well as a process of aeolian destruction of the ancient rock systems. Aeolian loess covered the slopes of Kunlun, at the foothill area the occurrence of loess was complex; both aeolian and alluvial deposits were involved.

An important point in the Quaternary history here is the up-lifting of mountains, that surround Kashgaria, by 600-1,000 meters, Kunlun itself rose by more than the final angle of inclination of the Kashgar depression towards the north, towards the foothills of T'ien-Shan, where the rivers directed their courses. In the south the lake next to Kunlun sank, the outline of the river network came



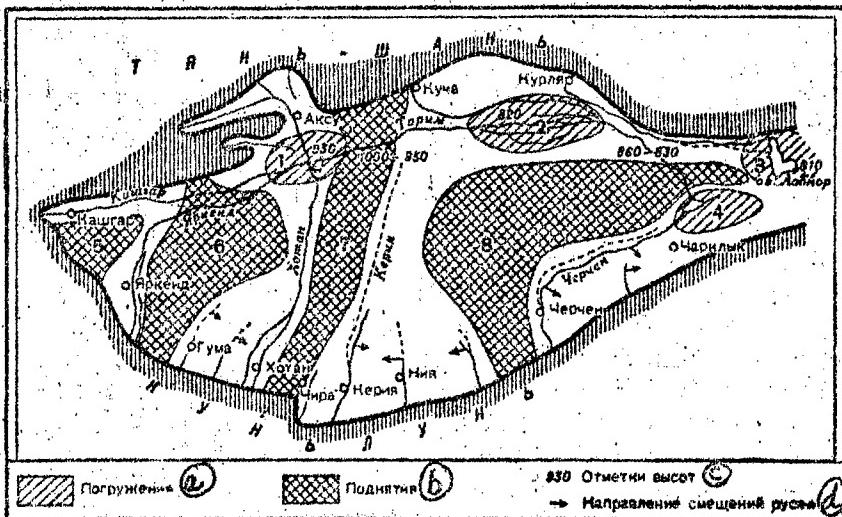
## Basic features of the tectonic relief of the Tarim depression during the Pleistocene period (according to V.M. Sinistsyn).

Legend: a. The fringe of mountains around the depression.  
b. Depressions.  
c. Tilted intraplatform elevation.

to resemble the one existing at the present time. Final erosion took place at the depressions in the east of Kashgaria, during the Cretaceous and Lower Tertiary period some of the more depressed regions were found in the west, which may be compared with the present position of the Hungarian depression.

The uplifting of mountains increased the isolation of the Tarim basin, dryness increased, the desert and the shifting sands expanded in area. The present day accumulations of sand at Takla-Makan must be regarded as the result of an aeolian treatment of the river and lake deposits, which were brought down from the mountains surrounding Kashgaria. The shift in river courses occurred in the past, and is continuing at the present time; tectonic factors are at the basis of these shifts in river courses. An uplifting movement between Tarim and Cherchen accounts for the migration of the Tarim to the north, closer to T'ien-Shan, Cherchen to the south towards Kunlun, and of Niya Darya towards the west. In general the present day features of the tectonic relief of the Tarim basin are not stable. Clearly differentiated sunken and uplifted areas are seen here; the valleys are etched up to a depth of 50 meters along the Khotan and Kerin rivers as well.

Let us turn to the physical-geographic characteristics of Kashgaria.



Basic features of the tectonic relief of the Tarim depression during the present period  
(according to V.M. Sinitsyn)

Legend: a. Sunken areas; b. Elevations;  
c. Altitude; d. Direction of river  
bed displacement.

1. Abad; 2. Shakh'yar; 3. Lop Nor; 4. Karakoshun;
5. Yangigissar; 6. Meralbash; 7. Koshsatmin;
8. Shaoshang.

The classification of Kashgaria into basic types of landscapes is simple. The following types are differentiated here: 1) The sandy desert of Takla-Makan, which occupies the principal central portion of the Kashgarian depression; 2) The barren foothill plain where the main agricultural oases are concentrated, and stand out as spots of green; 3) Valleys which contain rivers that flow through or skirt Takla-Makan and create narrow strips of landscape that present a vivid contrast to the surrounding desert landscapes.

The initial landscape of Kashgaria was almost entirely hidden under a thick layer of Quaternary deposits, sands, loess, etc. Basic rock material is clearly differentiated and forms small ridges or elevations of the type found at Mazartagh in the western part of Takla-Makan.

The only relief moulding factor of the sands of Takla-Makan existing at the present time is aeolian. According to research conducted by K. I. Bogdanovich, the sands of Takla-Makan are divided into two categories: sand that was created on the spot as a result of erosion of the Kashgarian rock and shifted by the

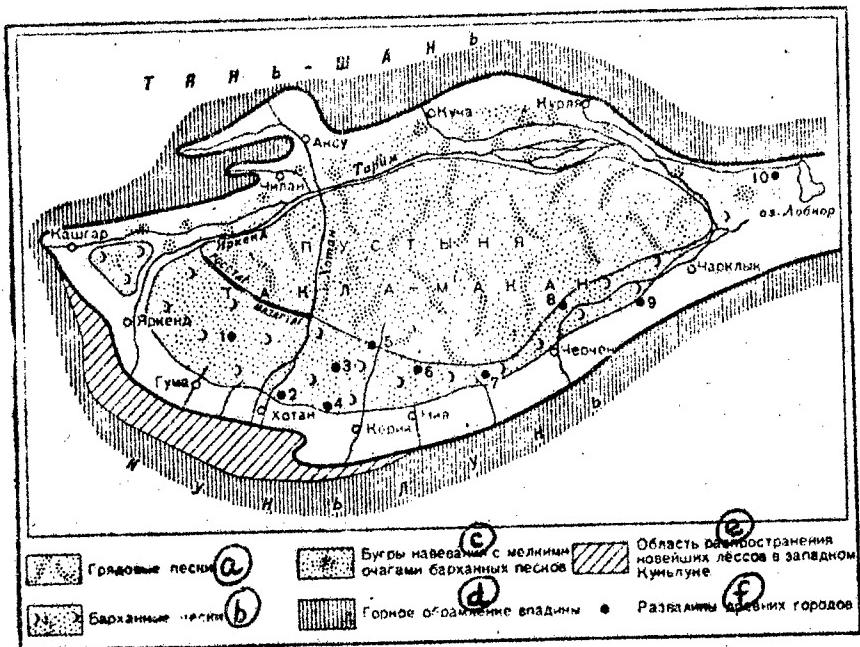
winds; it is dark in color sharp edged and contains an abundance of quartz, spar and no mica. The second type of sand is lake-alluvial, it has been deposited by numerous rivers, that flow from the neighboring mountains into the Kashgarian depression. This type of sand is light, smooth, homogenous and contains mica. This alluvial type of sand predominates.

The author cited above points out the following sandy terrain relief features; barchans, chains of dunes, sand ridges, mounds of sand and shifting sand dunes; rows of barchans, interspersed with mounds of sand are common. Such mounds of sand attain heights of up to 35 meters, and the ridges of sand are as high as 15-20 meters. In the center of the desert the sand is piled in formations up to a relative height of 60 meters and forms a hilly and almost inaccessible region with scanty vegetation that is unable to secure the bare and shifting masses of sand. In general the bare, shifting sands of Takla-Makan, devoid of vegetation, sharply differentiate Takla-Makan from other sandy deserts of Middle and Central Asia.

The sandy deserts of Kashgaria are striking in their lack of vegetation. There are no desert plants here that fasten the sands with their roots and are common in Pribalhash and Turkman deserts.

At Takla-Makan the tall ridges are arranged along the meridian, this is the most common arrangement in Kashgaria. The sandy desert here is bordered by an intermittent belt of low loess knolls, covered with a thin layer of sand and overgrown with tamarisk bushes. These knolls were also the result of aeolian processes.

It is frequently possible to encounter the term "yardang", which apparently is derived from the uighur word "yar-tag" (a precipitous mountain or hill), in geographical literature on Kashgaria. The yar-dang are small residual features arranged in parallel rows. They are usually composed of inclined layers of loess and sandstone and are easily eroded and shifted and under the influence of the predominating winds assume elongated shapes. Their height, according to observations made by V. E. Masibrod (1952), vary from 0.5 to several meters, they are from 2 to 5 meters wide and 50 or more meters in length. The yar-dang create a peculiar relief of the loess plains sloping areas. The yar-dang relief is a characteristic of the Tarim lowlands, the northern edge of the Lop desert, the Turfan depression, the Kumdar valley and for the border regions of Peishan. Their origin must be associated with erosion by temporary water flows, and delta waters due to the susceptibility of the soil to erosion and the slightly inclined level of the plains, as well as with erosion by strong winds under the desert conditions and a lack of vegetation. A characteristic feature of the Kashgarian relief are the sai. This term here has a different meaning than in Kazakhstan. See Note 7. In Kashgaria, the sai are dry, compact, and level the gravel-pebble covered platforms, which form the plains around the mountains. Sai are limited to the



The pattern of aeolian deposits in the Tarim depression  
(According to V.M. Sinitzyn).

1. Koni-Cuma; 2. Ravak; 3. Dandan-Ulek; 4. Uzun-Tati;
5. Kara-Dong; 6. Koni-Niya; 7. Endere; 8. Koni-Cherchen;
9. Vash-Sheri; 10. Lou-Lan.

Legend: a. Sand ridges; b. Barchan sands; c. Sandmounds with small sand dunes; d. Mountains surrounding the depression; e. Areas of fresh loess in western Kunlun; f. Ruins of ancient cities.

fringes of Takla-Makan; they border the foothill loess plains and occasionally extend for quite a distance towards the interior of the desert where they are found between the sand ridges or interspersed with salt flats. The latter type are characteristic to regions containing ancient river beds, and are attendant to present day lake valleys and depressions. Salt flats surround Lobnor in a wide circle. The sai landscape in Kashgaria may be compared with the foothill areas of North-African deserts. Foothill gravel or sandy-gravel sai. Vegetation here is very meager, the Przheval'skiy joint fir tree is noted, Roborovskiy calligonum, and thistles.

Note In Kazakhstan - say; in Turkmenia Trans-Caucasia and Turkey-chay; in Mongolia-sayr, dry beds of temporary rivers. In Turkey and Trans-Caucasia chay-river valley.

The foothill area irrigated by water from the mountain rivers is covered with oases, loess and loess type soils are predominant here. The landscape moulded by the nomads around these oases has



A sketch of the lakes existing during the early Holocene period.

1. Southwest of the Tarim depression;
2. Lop Nor lowland area;
3. The lower course of the Edzin-Gol;
4. Southern Ordos.

Legend: a. Lakes of the early holocene period.

completely changed from the natural desert landscape. The oases are crossed with irrigation canals in every direction, and enclose blooming orchards and cultivated land. The absolute altitude of these oases varies from 1,000 to 1,500 meters.

Some of the larger Kashgarian oases are Kashgar, Yarkand, Khotan, Keriya, Cherchen, in the north of Aksu, Kuché, Bai with Sairam and others. The largest oasis is Kashgar and covers an area of approximately 3,000 square kilometers.

Oases extend along the mountains not in a continuous row, but are separated from one another by tens and even hundreds of kilometers. Between the irrigated lands are the desert foothills, which are here called kyrs, as well as sand or poplar groves.

At one time the poplar forests fringed Takla-Makan a narrow strip and formed the intermediary belt between the desert and the mountains. But at the present time little is left of these wooded areas. Many of the present day oases have developed on the site of these poplar forests that have been felled. Poplar trees create a peculiar landscape on the alluvial soils, where the trees, growing in groups form groves, which are interspersed with scattered single poplar trees. Dryness here is evident in everything. The poplar forest here has no underbrush, its flora is very poor and includes only ten or twenty varieties of plants (M. G. Popov). Desert poplars are represented by two varieties; in addition to those there are tamarisk, thistle and reeds which are common here. Tamarisk quite frequently form dense thickets in this belt.

The area of transition from the preceding one towards the mountains of Kunlun and T'ien-Shan is composed of kyrs, i.e. low foothills eroded by water, elongated flat topped small hills, knolls, as a rule, with even surfaces. The gravel, twigs and chips

of rock, that compose its surface, are washed away and have been included in the cover of the lower level sais.

N. A. Beliavskiy published new data on the geography of the western portion of Takla-Makan in 1947. He points out the plain zone, which fringes the sandy region from the west and south. These are remnants of an ancient alluvial plain. Its surface contains scattered mounds of sand overgrown with weed, tamarisk and Euphrates poplar. Isolated groups of sand dunes are encountered in the south where the vegetation is scarce. It is important to note that the plain is crossed by ancient and presently dry river beds, formerly filled with water from the Tarim, Tiznaff and from rivers flowing off Kunlun.

The second region in the western part of Takla-Makan is covered with sand and is called "the sandy massif" by its explorers. Some vegetation is encountered along its edges, which form excellent grazing land, in the interior, however, the sand assumes different forms - ridges, which consist of closely grouped dunes on the surface of sunken areas, where an occasional well shaped sand dune is seen.

The orientation of all the elements here is meridional, the sloping side of the barchans face north while their windblown side faces to the south. The relative height of the barchan rows is 50-70 meters and infrequently 100-120 meters. The third region consists of Nazartagh and Ross Tagh elevations (the latter name was given by N. A. Bel'yavskiy in honor of the first Russian explorers of Central Asia.)

Monoclinal elevations, composed of Tertiary rock and having an absolute height of 1,300-1,400 meters and a relative height of 60-350 meters, extend in the deserts west of Khotan. The direction of this line of elevations follows the Kunlun bend. Nazartagh and Ross Tagh geologically fresh formations; they occurred during the Quaternary period. During the first period of geological development a great role in the moulding of the relief was accomplished by water. Such relief features as ravines, piedmont areas and salt flats were created in the desert mountains. The accumulation of loose matter is associated with this period, which was more humid than the present one; this matter was deposited by Tarim and other rivers and contained freshwater fauna.

In the south of the desert piedmont loess and loess type loam were formed.

During the post-glacial period decreased humidity and barchans occur; the area occupied by them increases, many salt flats become dry, loose deposits are vigorously shifted by the wind and are moved to the lower slopes of Kunlun, where they are found deep in the mountains. The aeolian factor is the only one and the most important one in the sand region and in the elevations of Ross Tagh and Nazartagh ("News of the All-Union Geographical Society," vol. 79, issue 4, 1947, pages 417-426.)

The moisture-loving vegetation of the Kashgarian river valleys extends in a thin line along the present day rivers and partially along the large dry river beds, where a high level of the ground waters as well as the residual flood waters remaining in some of the deeper spots of the river bed are conducive to the development of forest vegetation, which accompanies the river beds in a strip that is sometimes several kilometers in width. Such strips of vegetation penetrate deep into the sandy regions of Takla-Makan, along the Keriya, Niyan Darya Khotan and are the paths along which the big roads between the T'ien-Shan and Kunlun oases are laid, the homesteads of infrequently encountered nomads of the Kashgarian desert occasionally encountered here.

Such vegetation areas usually support poplars, elaeagnus, willows, of course tamarisk, reeds and other plants all of which are common in Kashgaria.

Rivers of the Tamir basin, as indicated above, have a great economic significance. Activities of the Kashgarian farmer are associated with the river. The role of the rivers is likewise great in the formation of the Kashgarian landscape. Due to the rivers the tremendous accumulation of Quaternary deposits was made possible in this country. The rivers that run dry upon entering the plains of Kashgaria and yielding their waters to the ground, serve as a source for the underground water streams, which penetrate deep into the deserts.

The principal water artery in Kashgaria is the Tarim river, which is known to the local population as Yarkand Darya. See Note 7. Tarim's sources lie in the Kunlun mountains and are known under the name of Raskem Darya; they are found at altitudes of over 5,000 meters. The largest tributaries flow into Tarim from the left, while the tributaries on the right fail to carry their waters to their mouths.

Note 7 Tarim - from Mongolian word - tarya-sown land, agricultural river or, as explained by M. V. Pevtsov, it is so called because it fed the inhabitants with fish, it was a river-provider. Yarkand named after the Yarkand river is called by that name because it means a city on a precipice, or yaru.

The left tributaries, that flow off T'ien-Shan: Kashgar (at its upper course called the Kysylsu), the occasionally dry Aksu, which is the second tributary flowing into Tarim and contains more water than the Yarkand Darya itself, Muzart and the deep and clear Khotan Darya that flows out of Lake Bagrach Kul.

The right hand Kunlun tributaries: Khotan, Keriya, Niyan Darya, and many others do not empty their waters into Tarim and therefore are of no significance to it. All of them, with the exception of Khotan and Keriya are used up for irrigation at the oases, and what remains is absorbed by the loose desert deposits. Khotan, whose valley is clearly outlined in Takla-Makan, cuts across the desert and under unusually damp conditions carries its

remaining waters as far as the Tarim river. The principal portion of this abundant flow of water is used up for the irrigation and is absorbed or evaporates on the Kashgarian plains. The flood waters of the Khotan reach the center of the Takla-Makan desert, and puddles of water remain on the bottom of the river bed throughout the year. The Keriya river also carries its waters up to the center of the desert, but never reaches the Tarim river.

The Tarim river fringes the sands of Takla-Makan on the north, and loses part of its waters through evaporation and absorption, but still occasionally reaches Lop Nor.

The Tarim is 1,800 kilometers long, its breadth in the Kashgar depression is an average of 80-90 meters; in some spots however, the river spreads to 850 meters; during the winter it is shallow, and during the summer it increases up to 4 meters, and as deep as 10 meters in some spots, that is why Tarim is suitable for navigation. In its lower course Tarim splits into several branches, which like the main river bed occasionally change their position in the plain.

The history of the source of Tarim contains a number of indications of numerous changes in the course of its waters and their connection with various places in the Lobnor depression. At the present time one of the branches of Tarim along with Cherchen Darya flow along an ancient bed of the Kundar river and after 250 kilometers empty into Lake Lop Nor, which is why that lake shifted to the north. Another branch filling a small lake called Karaburan Kul empties its water into marshes and salt flats located in the southern end of the Lop Nor depression. This same small lake Karaburan Kul receives the waters of the easternmost Kunlun river, which reaches the plains of Kashgaria, and is called the Cherchen River.

A characteristic feature of the regimes of the rivers of the Tarim basin is a sharply differentiated high water period during the summer, as their water source lies in the high glacier and snow covered mountains of Tien-Shan and Kunlun. All the rivers there have a widespread hydrographic network in the mountains, in the area where they receive their waters, where they then etch the bordering mountain ridges that fringe the Kashgar depression with narrow and steep gorges. In these gorges the rivers form powerful and rapidly flowing torrents, and upon leaving the gorges they flow slowly in a single stream within the depression, often failing to reach another river or to empty into a lake. During the summer during the high water period, the water level rises sharply, the current increases in speed, and the amount of foreign matter in the water increases to a point where the water appears completely brown and unpotable. Light clay and loess soils through which flow the rivers of Kashgaria are the cause of such a high saturation of the water with mineral matter. As a result of this same reason a number of river beds change their position on the plains, where

the easily eroded loose soils allow the river to quickly cut new courses. The blocking of old river beds with matter being carried by the waters is frequently another cause for the rivers to seek new courses. It is known that the Tarim changes the course of its waters not only in the delta area but at its lower and partially its middle courses. The Khotan, Muzartagh, Khonchdar and many other rivers have also altered the position of the lower portion of their courses. Ancient dry river beds have been preserved in the Takla-Makan desert, along the banks of which the ruins of ancient cities have been found. It is undoubtedly true that the change in the course of the old rivers brought about the dehydration of the rivers that supplied water to these cities which led them to perish. Remains of these cities are still seen today in various parts of the desert, they are partially covered by the shifting sand of Takla-Makan.

Let us cite some data regarding a central Asian lake, Lop Nor, which is so well known to the geographers for such a long period of time, it is mentioned in some ancient Chinese sources.

Lake Lop Nor, or Kara-Koshun, is of course the most remarkable one of all the lakes of Sinkiang. It is mildly saline, and near the point of its entry into Tarim it contains fresh water. Lop Nor occupies the lowest depression in Kashgaria (780 meters), but has no clearly delineated shores, as the Lop Nor depression is a broad lowland area, along which the lake meanders. Many articles have been written about Lop Nor; its true position was disputed for a long period of time. The dispute was initiated by Richthofen and Przheval'skiy. It turned out that in connection with the changes in the course of the end branches of Tarim, Konchedar and Cherchen, the lake as well perambulated along the Lop Nor salt plain. According to old Chinese maps, which were used by Richthofen, the lake was recorded as being much farther north than where it was observed by Przeval'skiy. However, since Przheval'skiy's time the lake again moved towards the north from where it was described by Przheval'skiy, and occupied approximately that hollow, which was recorded by the Chinese on their ancient maps.

According to M. V. Pevtsov's descriptions, in 1890 Lop Nor was 100 by 40 versts in size. The lake is shallow, and became densely overgrown with weeds, and surrounded by knobby salt flats, which extended over considerable areas. Parts of the lake were uncovered, where the depth of the water was 4 meters. According to N. M. Przheval'skiy, the average depth of this lake fluctuated between 0.9 and 2 meters, and was infrequently as deep as 4.5 meters. According to the local inhabitants, at that time Lop Nor was growing shallow and from year to year contracted in size. It is natural that a lake like Lop Nor must have a strongly fluctuating water level and area covered by the water.

Local Lop Norites are intensively engaged in fishing, as the

lake is abundantly filled with fish. There are many wild boar around the lake, which are hunted by the tigers.

The present day maps show Lop Nor as having an area of 50 by 100 kilometers; these figures, however, are quite unsteady, and they must be considered as approximate, due to the frequent changes in the shoreline.

This does not end the description of Lop Nor. The following question involuntarily arises: what will be the future of Lop Nor? And here are the new amazing events that occurred at this nomad lake. In 1950 a worker of the All-Union Institute for the Conservation of Plant Life, E. P. Tsyplennikov had the opportunity to visit the Lop Nor desert, but he failed to find a lake. Here is what this traveler wrote: "Lake Lop Nor, which we visited, is located approximately 240 kilometers northeast of the city of Charklyk, i.e. almost at the same location where it is shown on the Chinese map of 1950. The lake's dimension, however, do not coincide with those indicated on the map. As we approached it, it appeared that the lake was covered with what seemed to be a layer of ice. Having reached Lop Nor, we became convinced that it was a solid layer of salt. At the time of our visit Lop Nor contained no water at all, with the exception of a few small puddles. The points where Konchedar and Tarim entered the lake are visible, but the river beds are almost completely covered with sand. The shores of the lake were completely barren and dead."

According to the local inhabitants water ceased to flow into the river since 1942, in connection with the fact that both the Tarim and Konchedar, having changed their course in the vicinity of the city of Tikenklik, turned sharply to the east. The water of these rivers at the present time disappears without a trace into the sand. It is conceivable that after a period of time a new lake will form here again; it will be called Lop Nor but it is not there now." ("Nature, 1952, No 11, page 124.)

P. K. Kozlov in his excellent article entitled "The Nomad Rivers of Central Asia" (1935, pages 599-601) wrote that the cause of Lop Nor's shift -- is the eternal aspirations of the wandress river Konchedar to the east. The most recent history of Lop Nor substantiates this theory.

In 1950 Lop Nor, therefore, almost completely disappeared. But in 1952 the bluish glint of a shallow lake was again seen in the Lop Nor depression, but of a totally different shape than that shown on the maps; its area has diminished. The fate of Lop Nor seems to point to a slow but certain death. Perhaps the temperamental Konchedar and Tarim rivers will once again cut new courses, which will be filled with water and will create rivers and lakes in new places. This may happen. But more than likely Lop Nor will die completely.

Lop Nor represents a great evaporation bowl, where fresh water so precious in the desert is uselessly expended, while a

strong need for it is felt in the Kashgar oases. The presence of water would have permitted an expansion of these oases over dry and infertile lands of the loess deserts. And even now, of course, the farmers of Kashgaria will be able to use the water resources of both Tarim and Konchedar and direct their waters for the irrigation of new oases. And this will be felt at the lower courses of the rivers, in the Lop desert which will be reached by still less water as a result of its use in irrigation canals. This is already in the near future.

The New China is striving to use the natural resources of its country in the most rational and productive manner possible. The peoples of Sinkiang together with all the people of China are conducting a great program of construction of the socialist society. Under conditions of a People's Democratic Government they will be able to utilize the water resources of the Tarim river to a still greater degree.

In the geological past Lop Nor occupied a much greater area than it does at the present time, and had a direct connection with the neighboring Lake Halachi, which is located in the eastern extension of the same depression. Traces of an ancient shore ledge of the Great Lop Nor are still seen at Kuruktagh. The lake that is filling Takla-Makan, must have gradually shifted to the east, as the western portion of Takla-Makan became rapidly filled with deposits, that were brought down from the neighboring mountains.

This conclusively points to the fact that in considering the question of the present dehydration of the climate and the lakes of Kashgaria the fact that the disappearance of arable land and the death of the ancient cities may have been caused by a regular shift in the course of the rivers, as well as by the constantly increasing use of the river water for irrigation, which is an important factor and must also be taken into consideration. Let us also add that the dehydration of the rivers is associated with the change in their hydrographic regime which is caused by an increasing amount of river deposits, which are brought and deposited by the rivers in the foothill plains. These alluvial deposits are conducive to greater absorption and a more rapid exhaustion of the water of these rivers, than that which occurred in the past. This process which took place throughout the Quaternary period did not cease by the present time. Let us point out that Takla-Makan is exceedingly poor in vegetation; it does not have even the Haloxylon plant.

#### KUNLUN AND OTHER MOUNTAINS SURROUNDING THE KASHGAR DEPRESSION ON THE SOUTH

The mountains that circle Kashgaria in the south and border Tibet on the north, are part of the greatest mountain structures of not only the Asiatic continent, but of the entire world. This

part of Central Asia is dominated by the Kunlun range - "the spinal column of Asia".

Kunlun like T'ien-Shan is not a single mountain range, but represents a complex system of many parallel or almost parallel ranges interconnected in a generally converging pattern, which is clearly traced by the passes from range to range, as well as by the importance which is presented by Kunlun system as a basic watershed of Central Asia. Kunlun forms the border of the following basins: Tarim, the non-draining basins of Western Tibet and Gobi, the Yangtze and the Hwang Ho rivers. It must be stressed that the basic watershed of Central Asia is the Kunlun system on the whole, and not some main range. A main range cannot be differentiated as a single range for the entire great length of the Kunlun mountain system. In the extreme west the watershed functions are performed by Karakoram, and the so-called main range of Kunlun is severed by Raskem Darya (upper course of the Yarkand), Kara Kash and by other rivers.

In the extreme west of Central Asia Kunlun is orographically tied in with Hindukust, Eastern Pamir and T'ien-Shan as well as with Karakoram.

As a result of the fact that the borders of the stable Tarim massif lie farther to the east, the Kunlun and T'ien-Shan ranges converge here, while the Kunlun range which follow a north-western direction are in direct opposition to the T'ien-Shan structure which has a southwestern orientation.

The Kashgar mountains represent the watershed of the Amu-Dar and Tarim and are the connecting links of the gradiose Kunlun, Pamir and T'ien-Shan chains. This high elevation is crowned by three first rate mountain summits called Muztagh Ata (7,546 meters), Khongor (7,719 meters) and Karaboktor (6,634 meters), which are capped with eternal snows and contain glaciers. These summits are located on the principal range, which is the north-western extension of Kunlun; Sarykolskiy range, which borders on the Soviet Union, extends to the west of it.

A peculiarity of the mountains of Kashgaria is their sharply etched peaked summits which are clearly seen from the distance. It is not without basis that they are sometimes referred to in literature as the Kashgarian Alps.

Broad valleys are covered with high mountain pastures ("yayla", which is the name for Crimean pasture lands, in the Kazakh - dzhaylyau, in the Altai - Yaylyu, etc.), and steep, narrow ridges. The main roads that pass through these yayla are situated between the main ranges of Mustagh Ata, Sarykolskiy. They stretch out almost meridionally from the northwest to the southeast and lie at great altitudes (3,200-3,700 meters). The rivers leave these through wild and craggy gorges, where the river beds are surrounded by bush and the wider passes are covered with more dense vegetation including poplar, willow, birch, sea buckthorn, pea trees, etc.

The lower mountain areas are very barren and gradually turn into the foothill deserts of Kashgaria. The mountain ridges are composed of ancient crystallized rock, gneiss, granite, and quartz.

In the north the Kashgarian mountains are connected with the Trans-Alta Range -- the eastern extremity of which is located within Kashgaria, and the main portion of it is located in the USSR. The Alta valley forms the border between the T'ien-Shan and the Kunlun structures.

Two factors, the present and ancient glaciation, have effected the landscape of the upper portion of the Kashgarian mountains in a most concrete manner. The glaciers are at the present time very well developed in the Kashgarian mountains, particularly at the Khongor and Muztagh Ata massifs and the Kingtau range.

See Note7.

Note7 Muztagh Ata in Turkish means "father of ice mountains".

Karakoram See Note7 -- is one of the greatest mountain ranges in the world, which stretches out from Pamir south of Kunlun and was created through Alpine folding. The grandiose nature of Karakoram may be judged by the number of its very tall summits. With a comparatively short length of 400 kilometers Karakoram has average height of up to 6,000 meters and the maximum height at the Chogori (Godwin Austen) summit is 8,611 meters (second highest summit in the world); in addition to this summit there are 16 other summits with altitudes of over 8 kilometers and tens of summits with altitudes of over 7 kilometers. The passes at Karakoram lie at altitudes of 4,600-5,800 meters; the most popular one of which bears the same name as the range, and ties Kashgaria with Kashmir See Note7 on the Yarkand-Lech road and is located at an altitude of 5,575 meters. This road is well described by V. F. Novitskiy, a Russian traveler. Certain passes are close to floating glaciers and their accessibility is closely associated with the glaciers' surface conditions.

Note7 The name "Karakoram" - meaning "black rock, black scree"; is translated by some as "the black throne" after the name of a well known pass.

Note7 The frequently encountered geographical terms including the word "kash", are apparently associated with nephrite, for which the mountains of Western Kunlun have been well known since time immemorial. Such names are: Kashgar, Yurung Kash, Kash Darya, Kara Kash and many others.

Karakoram consists of three parallel ranges and several spurs, that are also tall and snow capped; the relief of both the main range (Muztag or Lapsang), and that of the spurs is very abrupt with steep and craggy features and deep, precipitous gorges. The slopes of this range descent unevenly; the southern slope is long and very steep, and the northern slope within a short distance rests itself against the high valleys and plateaus at the upper course of the Tarim river (Raskem Darya and Karakash

rivers).

Masses of crystallized rock, granite, gneiss as well as metamorphized limestone participated in the formation of Karakoram. Folding processes performed the principal rôle in the formation of the Karakoram ranges, and of the neighboring Himalayas; however, folding at Karakoram occurred earlier during the Mesozoic (Triassic) period. A great rôle in the geological construction is performed by the Pre-Cambrian granite, gneiss, etc. Mesozoic (Jurassic and Cretaceous) deposits have a limited distribution in the southwest closer to Tibet.

Taking into consideration the great height of the Karakoram it is possible to state that ancient glaciation performed a big rôle during its Quaternary period of evolution. Even present day glaciation assumes grandiose proportions here. Glaciers are characteristic for both slopes, a greater glaciated area is however found on the southern, moister slope, which is open towards the Indian Ocean. The greatest glacier in Karakoram, Baltro, is located here; it is 66 kilometers long. The second glacier, Biafo, is only a few kilometers shorter than the first one (60 kilometers). The glaciers descend on the average to an altitude of 3,050 meters (2,878 to 3,530 meters on the southern slope), whereas the snow line fluctuates between 4,700 to 5,900 meters; while on the northern slope it is much higher than on the southern slope. Such a reversed relationship in the snow line levels, as compared to the usual arrangement, underlines the exceptional dryness of the northern Central Asiatic slope and the moisture of the southern slope. Approximately the same circumstances are observed at the Himalayas as well.

The northern slopes of Karakoram are rocky, stony and almost devoid of vegetation; some scrub is found only along the edges of streams. The lower belts of Karakoram, the broad and high altitude valleys of Rasken Darya and its tributaries (3,700-3,900 meters), vegetation is denser; along with the grass, poplar groves are seen as well as some scrub. Apricot trees grow at this altitude as well -- it is a common South Tibetan tree. The southern slope of the range, where the snow has already disappeared is covered with somewhat richer pasture lands, as well as forests that rise to an altitude of 3,500 meters. The lower belt is used by the Kashmir people for cultivation of crops. Various crops may be encountered here including such heat-loving crops as rice. In general the Karakoram range creates the impression of a cold and forbidding desert, which is common to the neighboring regions of Tibet.

The great Kunlun arc, according to Richthofen's proposal, is usually divided into three parts: The Western, Middle and Eastern Kunlun -- the borders between them have been generally unsatisfactorily determined and are not commonly accepted. Western Kunlun, according to Richthofen, extends to  $89^{\circ}$ ; Bogdanovich considers this strip as part of Western and Middle Kunlun. Eastern Kunlun accord-

ing to Richthofen lies beyond the borders of Central Asia on the territory of Eastern China. Such division must be admitted as not representative of the present day level of understanding. This is evident from the following.

Kunlun forms a colossal arc from the Kashgarian mountains to the Yellow river within the borders of Central Asia. Its concavity faces towards the north and fringes the broad, enclosed Tsaidam depression.

Not being a very great massif in the west (150 kilometers and less), Kunlun at first narrows down and then branches out in the east, where four parallel chains are found south of Lop Nor.

The northermost range bordering the Takla-Makan desert east of the Cherchen river bears the name of Altin Tagh. In the east it serves as a border between the Lop Nor depressions and the Tsaidam mentioned above. Altin Tagh is an intermediary link between Kunlun and Nan Shan in a tectonic and geological sense it is closer to Nan Shan even though orographically it is closely associated with Kunlun.

The absolute altitudes of Kunlun are in general greater in the western part of the range, whereas in the east its spurs become wider and somewhat lower. In the west, Kunlun rises in an imposing ice covered Mustagh Ata group to an altitude of 7,546 meters and in an even more grandiose Khongor group (7,719 meters) and the Muztagh group (7,282 meters). The Arka range (Rear Mountains), which was discovered by Przheval'skiy and later named after him, is dominated by one of the summits, Ulugmuz Tagh (7,723 meters). The second summit of this range, the Monomach's Cap, which Przheval'skiy considered as the main summit, turned out to be somewhat lower than Ulugmuz Tagh. From this, it is evident that Kunlun yields to the Himalayas in the altitude of its tallest summits, but in the average altitude of its ridges (6,000 meters) it is almost as tall as the Great Himalayas -- the average altitude of which is only 100 meters above that of Kunlun.

Note 7 In western Kunlun the passes lie at altitudes of up to 4,800-5,900 meters, and the elongated valleys between the chains of mountains are at 4,000-5,000 meters.

Note 7 It must of course be considered that the data, such as cited here on the ranges of Central Asia doesn't have a good topographical basis, and therefore has only relative value -- it indicates only the order of the dimensions.

More detailed information is available on Western Kunlun due to the work done by N. A. Beliyavskiy Note 7, who proposed the division of the external and the internal Kunlun chains with respect to the Tarim depression, which is fringed on the west with external chains that end with the Tekelik Tagh range east of Chirabazar. The external Kunlun chains separated from the internal ones by intermittent, elongated depressions composed of Mesozoic and Cainozoic matter. Tectonically they represent typical synclines.

Note<sup>7</sup> On the orography and geomorphology of the mountain areas of Western Kunlun. "News of the All-Union Geographical Society", Vol. 80, issue 3, 1948, pp. 234-245.

The southern ranges of Kunlun that border Tsaidam from the south and represent the basic border of Tibet are the main links of Middle Kunlun. They continue to the east as the Bayan-Hara-Ula watershed between the upper courses of Hwang Ho and Yangtze. These ranges are: Bakalyktagh (Marco Polo), Columba, Talay, Kukushili, Burhan-Buddha, Moskovskiy (Achikkol); they also contain some of the tallest elevations of up to 5,000-6,000 meters even though they are not covered with snow to as great a degree. This is due to the dry conditions and is concentrated only on some of the summits, as compared with observations made in the western portion of Kunlun. The principal link between the Western and Middle Kunlun is the imposing Przheval'skiy range (Arkatagh, which extends almost longitudinally (It slightly deviates to the south) and may be considered as the main range.

In the east, the Kunlun arcs turn to the south forming the grandiose Sino-Tibetan mountain ranges thereby skirting Tibet on the east and passing into Yünan. It was formerly considered that the direct continuation of Kunlun was the Tsinlin, Funyushang and other ranges. Geological data, however, permits the assertion of the fact that the Tsinlin and other mountain structures of Eastern China are a product of the Yanshang (Mesozoic) folding on the Chinese platform; whereas Kunlun even in the distant geological past is a mobile region, which is bordered on the south by the Tarim stable massif.

Within the last several years N. A. Belyaevskiy has reported on the stratigraphy of Western Kunlun. He has written that these mountains were composed of different complex matter. The most ancient strata are the Pre-Cambrian gneiss, marble, quartz and shale. The Paleozoic period is represented by metamorphized limestone, continental sand, marble, marl and clay.

The Mesozoic deposits in the Kunlun mountains are distributed to a much more limited extent than the Paleozoic sediments. This is associated with a change in the geosynclinal regime of Kunlun, which ceased to exert their effect by the beginning of the Mesozoic period. The deposits of that period are found in the north where they are represented by conglomerates, sandstone, argillite and partly by limestone, shale, and marl.

Tertiary strata are formed by shale, clay, gypsum, and conglomerates. The area over which the Tertiary deposits are distributed is rather limited. They are mostly found in the inter-mountain depressions that are parallel to the mountain chains. The depth of these strata attain hundreds of meters.

According to data furnished by N. A. Belyayevskiy, excavated loess covered with a fine dust of graminous and bush plants, is noted in the Pleocene deposits; plants of the same type cover the

borders of the Takla-Makan desert at the present time.

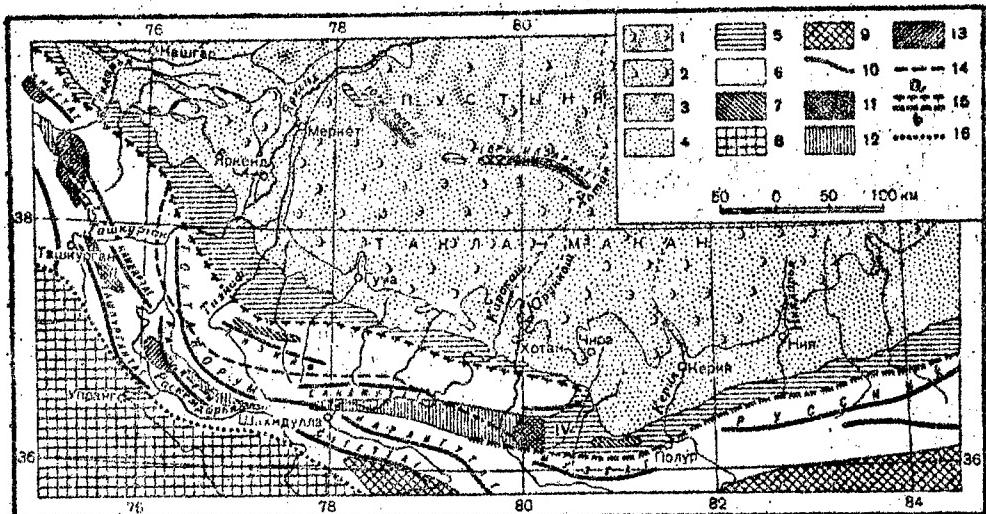
This researcher attributes the glacial, aqueoglacial and alluvial deposits, the younger loess, the loess-like loam, sand, terrace pebbles, the basalt effusions and andesites to the Quaternary deposits.

By the end of ancient glaciation an intensive process of loess formation took place as a result of an increase in the dryness of the climate. Loess covers the slopes of Kunlun masking the uneven relief features. Only the rocky summits and the ridges rise above the loess cover; this is evident even on the ancient moraines.

During the postglacial period the rivers of Kunlun cut deeply into the mountains and created grandiose, eroded gorges; the greatest incision is noted in the valleys of the Tarim system in connection with its relatively low susceptibility to erosion. The depth of the incision of the Yarkand river by its mouth is 550-650 meters above, and below that point it decreases. Ancient glacial valleys having depths of up to 1,500 meters, were made deeper through further erosion by an additional 500-700 meters. The eroded valleys contain no loess -- it has been washed away and redeposited at the foothill valleys of Kashgaria as secondary alluvial loess.

A characteristic feature of Kunlun as well as of T'ien-Shan is the position of its mountain chains, which was first noted by a member of the Tibetan expedition, K. I. Bogdanovich, in 1889-1890. These mountain chains arranged like a series of links are separated by elongated mountain valleys, which have the appearance of deserts, and thereby resemble Tibetan landscapes.

The northern fringe ranges of Kunlun are --- Chongkyr, Kingtau, Muztagh and others; they descend in a steep grandiose wall towards the Kashgarian depression. Numerous but mostly shallow rivers flow down the northern slopes, but by the lower levels of the slopes they disappear completely in the desert, which rises along the mountain slopes up to an altitude of 2,000 meters. Only a few of the rivers reach the Kashgarian plains, and some cut through the forward apron of Kunlun along grandiose canyons (Khotan, Keriya and others). Low foothills stretch alongside the slopes. The interior portions of the range are dry and somber. Plant life is very scant here: gravel deserts, glacier deposits, snow, and small glaciers cover the main Kunlun elevations. The range is therefore virtually inaccessible, and the passes go through several high and difficult points. The southern slopes of Kunlun are narrow, very steep, and frequently waterless; they pass into high altitude valleys, partly representing non-draining basins. These valleys have both level and undulating relief features. Still containing glaciers, Kunlun has in the past undergone a much greater period of glaciation, which left numerous even though not always clear traces in the sea of moraines. Other traces of ancient glaciation



An Orographical and Geomorphological Sketch of the Structure  
of Western Kunlun. (According to N. A. Belyayevskiy)

1. Barchan-row landscape; 2. Barchan landscape; 3. Landscape of wind blown mounds; 4. The Kashgarian and foothill plains (including the foothill cones of eroded matter); 5. Landscape of the "bad lands" type in the foothill belt; 6. The glacier-erosion landscape of the mountain regions of Kunlun; 7. Regions where the mountain ledges (counters) are found on the northern slopes of Kunlun; 8. A glacier and partially eroded landscape of the Karakoram system of ranges; 9. Leveled surfaces and grouped ridges of the Tibetan Plateau; 10. Extensions of the main mountain ranges; 11. Orometric depressions and intermountain hollows at Kunlun with a cover of slightly dislocated Meso-Cainozoic deposits; 12. Orometric depressions without a cover of Meso-Cainozoic deposits; 13. Principal regions of present day glaciation: the Kingtau region, Khongor-Muztagh, Rasken; 14. The southern border of the maximum extension of aeolian loess at Kunlun; 15. Fringe gaps: a. those not having a geomorphological expression; b. those expressed in the form of a ledge in the relief; 16. The border between the Kunlun and Karakoram ranges. Hollows and orometrical depressions in mountainous Kunlun: I. Chicheklynskiy; II. Vachinskiy; III. Yangidavanskiy; IV. Chakarskiy.

are not as conclusive -- for instance, in Central T'ien-Shan, where the whole complex of glaciation forms is well observed. This is explained by the fact that glaciation was followed by a process of energetic wind erosion which was conducive to the destruction of glaciation scars, polished surfaces, and changes

in typical terrain features created by glaciation such as the ram's forehead, etc. The moraines are frequently covered with loess that masks the relief features created by glaciation. According to data compiled by G. Sobolevskiy who explored the western part of Kunlun, moraines along the northern slope descend in valleys to an altitude of from 3,000 to 4,150 meters; on the average to an altitude of 3,700 meters, which is the difference in the altitude of the lower limits of the contemporary glaciers and the ancient ones of 600-700 meters. K. Bogdanovich considers that the ancient glaciation of Kunlun could not have been very extensive, as the areas of the firn basins here are very limited, even though the snow cover in the western part covers the upper level of the range continuously. The abrupt descent of the river valleys and the great dryness did not promote the formation of glaciers, as during the period of ancient glaciation the general climatic conditions could not have been very much different from the present ones.

According to data compiled by Belyayevskiy the tips of ancient glaciers in the mountains between Yarkand and Khotan descended to an altitude of approximately 3,900-4000 meters, in the mountains over Yarkand to 3,350 meters, which was only 700-800 meters below the tip of the present glaciers. Belyayevskiy considered that ancient glaciation was considerable in area and was quite different from present day glaciation and he therefore does not accept Bogdanovich's opinion regarding the limited nature of ancient glaciation.

At the present time as well, both slopes of Kunlun are rich in glaciers; it is true that in size they may not be compared either with the T'ien-Shan or the Karakoram glaciers. The biggest glacier of the river Nasa is only 15 kilometers in length, and that of river Chigmen is over 16 kilometers long. A characteristic phenomena of the present Kunlun glaciers is the high altitude position of their lower extremities, which is easily explained by the dryness. The Kunlun glaciers have no side sources of water; in nature they are plain and are exclusively of the crust type (with the exception of the Pre-Pamir portions of the range). Wide valleys, which could become a source of water for the glaciers and the formation of firn, lie below the snow line; the fir line here is also quite high. The glaciers are supplied with water principally through snow slides, which is a common source of matter for the glaciers not only in Kunlun but at other neighboring mountains of Central Asia. A distinguishing peculiarity of the Kunlun glaciers is their very rapid rate of descent, which was noted by Sobolevskiy in the Prezhval'skiy glacier (20 meters for each 100 meters in length).

N. A. Belyayevskiy's material permits us to give quantitative characteristics of the contemporary glaciation of Western Kunlun. The largest snow and ice fields are concentrated, as should be expected, in the west. In the Pre-Pamir range of Kingtau

there are no less than 30 glaciers two to ten kilometers in length and with an area of ice-snow cover of 240 square kilometers. In the Mustagh Ata and Khongor region there are 32 glaciers with a combined area of 780 square kilometers. This greatest segment of Western Kunlun contains more glaciers than in the remaining portion of the range up to Niya Darya. A considerable portion of the glaciated area is found in the Duzakh massif, to the Karlyk Tagh range and others.

The tips of present glaciers in Western Kunlun, which was explored by G. Sobolevskiy, lie at altitudes of from 4,060 to 4,740 meters, and on the average at an altitude of 4,370 meters, which is considerably higher than at any other mountain region of Middle or even Central Asia.

N. A. Belyayevskiy cites the following figures on the absolute altitudes of the lower limits of glaciers for the Pre-Pamir portion of Kunlun: on the northern and northeastern slopes of the Khongor range the glaciers descend to an altitude of 3,800-3,900 meters, on the western slope to 4,100 meters; at the Muztagh Ata massif -- to 5,000-5,944 meters (the Kokselglacier on the northern slope). Towards the east, in connection with an increasing degree of dryness, the position of the glacier limits rises to an altitude of 5,000 meters. For the northern slope of the mountains in the Turgas valley Belyayevskiy cites a figure of 5,150 meters.

The snow line is likewise striking in its high altitude position. M. Pevtsov, indicated an altitude of 5,400 meters for the position of the snow line on the northern slope of Western Kunlun and 5,700 meters for the southern slope. K. Bogdanovich cites an altitude of 5,000-5,900 meters for the snow line on the Russian range; and in the west, according to data furnished by this author, the snow line is located at an altitude of 4,900 meters on the northern slope and 5,160 meters on the southern slope; according to G. Sobolevskiy, the snow line is found at altitudes of approximately 4,900 on the northern slope and 5,200 meters on the southern slope at the source of the rivers forming the Khotan. According to N. A. Belyayevskiy the altitude of the snow line at the Pre-Pamir portion of Kunlun is approximately 4,700 meters on the northern slope and from 5,000-5,250 meters on the southern slope. Farther to the east the snow lines are found at progressively higher altitudes, which rises to an altitude of 5,600-5,800 meters. East of the Raskem mountains the snow is found only in spots and does not cover the mountain ridges in a continuous blanket.

The positions and dimensions of the glaciers, as well as the altitude of the snow line and the distribution of the vegetation on Kunlun clearly indicates the bareness and dryness of this great range within Central Asia -- dryness that increases from the west to Middle Kunlun, but becoming less barren farther towards the east under the effect of the winds of Eastern Asia.

Kunlun which is situated between dry Kashgaria and somber Tibet receives little precipitation, which is substantiated by the data just cited regarding the position of the snow cover and of the glaciers. It therefore follows that Kunlun intercepts more of the precipitation moving with the northwestern air currents. The stony-gravel desert landscapes are characteristic to both slopes, but on the northern slope there are some steppes, and at one location -- the source of the Tiznaff river (Yarkand basin) on the northern slope of Western Kunlun -- K. I. Bogdanovich noted some fir groves, the lower limits of which are located here at an altitude of 2,900 meters.

#### TSAIDAM\*

The level of Lake Lop Nor is 780 meters, the average level of the high altitude plains of Tibet are 4,500-5,000 meters. The intermediary step between Lake Lop Nor and Tibet is a high altitude, gigantic intermountain depression called Tsaidam, that is surrounded by the Kunlun ranges. The lowest points on this depression are located at an altitude of 2,700 meters and its bottom is located between 2,700-3,000 meters.

\*Note7 The name "Tsaidam" is of Tibetan origin, but one that has become part of the Mongolian language and means tsay (tsva) -- salt plus dam -- dirt, marsh; i.e. salt crust.

The Tsaidam depression is of a tectonic origin. It is a syncline of Alpine age, which narrows to a broad intermountain valley (Gulach valley in the west and the Tsagan-Us valley in the east) in the west and east, it is tied with Takla-Makan and the Hwang Ho valley. Young Mezo-Kainozoic deposits, compressed between Paleozoic rock of Nan Shan and Kunlun.

Tsaidam is an enclosed and non-draining depression, which receives the waters of relatively small rivers (the biggest one is Bayan-Gol), that descend from the surrounding mountains, such as the Altin Tagh, Nan Shan, Przheval'skiy Range, and Burhan Buddha. Part of these rivers form small but frequently salt lakes and wide salt flats on the bottom of Tsaidam. Here on the bottom of Tsaidam underground water seeps to the surface, water that also has its source in the mountains.

The Tsaidam depression is approximately 800 kilometers long and about 300 kilometers wide. The lowest points are situated approximately at its center. The southern portion of the depression is represented by a plain covered with boundless salt flats along with short stretches of sand. The northern portion is somewhat more elevated, is covered by undulating and hilly plains where elevations are encountered. Pebble, sand and clay infertile deserts and semi-deserts are found here.

The vegetation in this part of Tsaidam is close to that found

in the dry Gobi deserts. Russian thistle, slender halophyte and other thistles are found by the alkali lowlands, and among the sands and clayey plains, the Dzungarian reamuriya and the prickly crazy-weed are seen. N. M. Przheval'skiy pointed out that wild camels are still preserved in the dry and uninhabited deserts of northern Tsaidam.

The nature of the southern portion of Tsaidam is more conducive to the nomad agriculture of the Mongols. Fresh water frequently appears in the foothill zone here, and the pasture lands are quite adequate for the maintenance of cattle. The alkali or salt flats are most widespread in southern Tsaidam, and are also not infertile. The scrub found here consists of thistles and tam-arisk that have an effect on the landscape. It is interesting that the first one of them, the thistle, which is peculiar to the Gobi deserts and semi-deserts, here in Tsaidam develops to a greater size and grows to a height of 1-2 meters and has the greatest crop yield. The thistle berries -- karmyk -- are commonly used for food by the Tsaidam Mongols, who even dry them for storage and use during the winter. The haloxyton plant appears in the sands of eastern Tsaidam, and reed is common around the spring waters; iris and sedge are also common here. The border areas are covered in places with bushes forming good sod such as the chiy (mongolian deris).

According to the amount of precipitation received by Tsaidam -- it is a desert -- the extensive evaporation that occurs at the Tsaidam lakes and salt flats absorbs the water received from the surrounding mountains. Places that these waters fail to reach are composed of clay, pebbles, scree and sand. It is not without reason that Przheval'skiy called Tsaidam "one of the most cheerless places on the surface of the earth."

Sand is found throughout Tsaidam, but the larger areas of sand are concentrated in its western part where they form into knolls that are poorly fastened with vegetation. Przheval'skiy compares them with the sands of Alashan, with which they have much in common both in relief and the size of the haloxyton plants that grow there.

\* \* \* \* \*

## TIBET

"The grandiose nature of Asia that is seen in the boundless forests and tundras of Siberia, or in the waterless deserts of Gobi, the great mountain ranges within the continent and the thousand mile long rivers that flow from there in all directions, has also manifested itself in the same spirit of overpowering magnitude in the wide upland area that covers the southern portion of the central area of this continent which is known as Tibet. Sharply differentiated on all sides with first rate mountain ranges, this country represents a grandiose irregular trapezium, represented by a table topped mass that is elevated above the sea level, with the exception of several border areas, to an overpowering altitude of 13 to 15 thousand feet, and in addition on that pedestal are piled extensive mountain ranges that are, it is true, relatively low within the country, but along its edges they assume imposing shapes. It seems as if these giants clip the almost inaccessible area of uplands country above the clouds that are inhospitable to man in their nature and climate and mostly still completely unknown to science...."

The brief geographic characterization cited above is from "Tibet in General" written by N.M. Przheval'skiy in 1883. It most succinctly conveys the physical-geographic specifications of this foreboding and high country, the exploration of which was the dream of many and reality for but a few chosen geographers.

The virtual inaccessibility of Tibet, its isolation from the remainder of Asia because of the high chains of mountains, the policies of the supreme ruler of Tibet, the dalai lama, more precisely his isolationism, forbidding any foreigner to enter the central portions of Tibet, led to circumstances which prevented science from learning its geography even in most general terms until quite recent times.

Tibet is the largest upland area in the world, both in size and in absolute altitudes; it is an upland area that occupies the southern and smaller portion of Central Asia. The borders of Tibet are for the most part clearly outlined by high mountain ranges: Kunlun on the north, Himalayas on the south; in the west Tibet becomes narrower, compressed between tips of the indicated ranges as well as those of Karakoram (See Note 7), and on the east it is bordered by the meridionally extended Sino-Tibetan mountains, along which passes the border of Eastern China.

*Note 7* The above survey includes Ladakh and Kashmir that are sometimes referred to as the Smaller and Greater Tibet. Geographically, these are extraneous regions, not relating to Central Asia. Ladakh is ethnographically an extension of Tibet.

In a physical-geographic respect, the Tibetan upland and the adjacent border mountains occupy an extensive area somewhat less than 2 million square kilometers. The average altitude at which

Tibet is situated is 4,500 meters; the mountains that traverse the surface of this upland, which is the highest in the world, frequently exceed 7,000 meters in altitude.

Such a high absolute altitude considerably complicates the exploration of Tibet. European travelers are severely affected by mountain sickness. Even the local inhabitants, who were born and raised in the mountains of Tibet, frequently become ill on crossing high mountain passes. The Tibetans call the mountain sickness "la dug," i.e. "poison of the passes". The extremely rarified air is felt not only by humans but the household animals as well, especially those carrying loads.

On the whole Tibet represents a cold and barren country, where animal breeding is extensive in the mountain grazing lands. Still the average population density is greater than that in other parts of Central Asia. This is partially explained by the presence of individually protected valleys, shielded from the cold northern winds, where agriculture is developed and the larger populated points and cities are located. Such valleys are the Tsangpo (Brahmaputra) valley and valleys of the rivers of southwestern Tibet. Two forms of agriculture are combined in Tibet, the settled and nomad form.

The name "Tibet", as the word "China", became known to the Russians from the population of Central Asia and from Mongols. The basis of this name is formed by the term Stod-Bod, which means the elevated Bod, i.e. Western or central Tibet. Eastern Tibet is called Mé-Bod (pronounced mé-pe"). The term "Bod" is very ancient, but it is known to the Tibetans to-day; it is basically Sanskrit; the Hindus use it at the present time to designate the Pre-Himalayan Tibetans (N.V. Kyuner) /See Note/. It seems that the same root "Bod" is in the name Buton, a Pre-Himalayan principality. The Mongols call the Tibetans Tanguts. From this stems N.M. Przheval'skiy's geographical concept "The Country of Tanguts"; this traveller narrowed that term to include only the population of Koko Nor. Tibet is known in Chinese geographical literature as Hsichiang, which means "western possessions".

The Tibetan uplands are a poorly studied portion of the Asiatic continent, and the research that has been done is primarily in the field of useful minerals. The lama church prohibited the exploitation of mineral wealth in the autonomous Tibet, which is why the population was opposed to its extraction. Gold, coal, various salts and other minerals were being extracted in the neighboring provinces of China for quite a period of time. The exploration and exploitation of the mineral wealth was deterred also by the poor transportation facilities. In Tibet it is said: "During January and March the mountains are covered with snow and it is impossible to travel; during April and June the feet sink in the mud; in July and September -- hurry on your way, for it is the most favorable time; during October and December the skin cracks from the cold."

Roads suitable for vehicular traffic have been only recently built to Lhasa, which have accelerated and facilitated the commodity turnover between Tibet and China by many times and brought Tibet "closer" to the centers of the republic. This road crosses certain passes that are situated at altitudes of over 5,000 feet above sea level. An important road lies along the Inda valley, which is also used by motor traffic travelling down from Lekha. The distance between Lhasa and Darjeeling, which has the nearest railway station, is 300 kilometers, a two week trip with pack animals.

#### Basic Features in the Structure and Morphology of Tibet and its Geographic Regions.

Tibet, in the broad understanding of this geographic term, is not an upland area homogenous in its relief and landscapes. Its geological history and present day geomorphological processes have been conducive to the creation of a peculiar physical-geographic image of the country, different both in the west and in the east.

Tibet in general is an upland area that is a result of folding, the tectonics of which is closely associated with the formation of the Kunlun mountains on the one side and of the Himalayas on the other and of the mountains of Central Asia on the third.

The formation of Tibetan mountains began during the Upper Paleozoic period when the regions framing Tibet on the north underwent tectonic movements. An important epoch in the formation of mountains of Central Asia occurred during the Mesozoic period. During that time Eastern Asia became the stage for mountain formation, which encompassed great areas (the Pacific Ocean phase), the Paleozoic mountain structures of northern Tibet were subjected to an extraordinarily strong pressure by these fresh movements, which re-moulded and rejuvenated the ancient folded structures of Central Asia.

During the subsequent Tertiary period the southern portion of Tibet became involved in the Alpine orogenesis, which resulted in the formation of the greatest system of folded structures in the Himalayas. It is natural that through its magnitude and power this Alpine orogenesis had the most profound effect on the surface features of all of Tibet and essentially determined the main features of its present orography.

During the Quaternary period a further development of the young mountain systems in the south of Asia is noted, in Tibet this was particularly felt in the southern mountain chains, which rose to their present high altitudes.

E.V. Kozlova, in analyzing the genetic and zoogeographic peculiarities of the ornithological fauna of the Tibetan upland area, attempted to reconstruct the Tibetan landscape in its preglacial

period. Such an analysis leads to a supposition that one of the typical Tibetan landscapes during the Neogene period was a hilly and dry steppe, that was located on a low hypsometric level. Frequent lakes were a characteristic of such a landscape. "The absence of sharply differentiated desert varieties of birds on the plateau indicates that during the preglacial period there could have hardly been predominantly desert conditions here. This thought is further substantiated by the variety of the sand-grouse that has evolved on the Tibetan uplands. According to its nature, the Tibetan sand-grouse is not suited for life in waterless, dry regions, even though its morphological basis belongs to one of the ancient groups of birds of the deserts....

Simultaneously with the predominant existence of xerophytic steppes and perhaps during a somewhat earlier epoch a facies of high grass growth may have existed on the Tibetan upland area....

Approximately at the middle of the Neogene period, at the time when a relatively moist climate was in effect, a scrub type of vegetation may have existed on the hilly plains -- a facies which evolved a monotype species of pseudo-jay.

The absence from the upland area of species, the origination of which could be associated with possible forest species, prompts a supposition that forest vegetation could not have represented a predominant, or even a perceptible element, in the landscape of this country, not until before the end of the Neogene period at any rate" ... (1952, pp. 1,025-1,026).

The vertical uplifting of the Tibetan Uplands, the changes in its relief, led to its population with certain Alpine species from the neighboring mountains.

The Tibetan Uplands are crossed by numerous mountain ranges that, in general, have a longitudinal and almost longitudinal direction, and in the east swing to the southeast. The difference in the physical-geographic conditions in the west and east of Tibet was the cause for such variegated landscapes in these parts of Tibet. Western Tibet is dry, the rivers there are shallow, they do not drain into the ocean, but end on the high plains between the mountains. At one time the internal ranges crossing Tibet were relatively even higher, but factors of denudation lowered them and the loose matter was deposited in the immediate vicinity at the foothills of these mountains, raising the level of the depressions between these mountains. The country was gradually being levelled, the difference between the positive and the negative relief factors was diminishing.

In the west of Tibet arid processes are active; these processes are vividly expressed. In essence the presence of a great number of small enclosed salt lakes on the surface of the upland area is the cause for such arid conditions.

The dryness of the air is well illustrated by the location of the snow line. The border of the eternal snows on the northern Tibetan slope of the Himalayas lies at an altitude of 6,000-6,100

meters or by 1,000-1,200 meters above that on the southern, Indian side that is more humid. Eternal snows start at altitudes of 5,700-5,900 meters on the internal ranges of Tibet, and at some individual points around 6,000 meter passes the snow is seen only in separate patches.

During the summer snow storms that cover not only the mountains but the plains of Tibet with snow are not infrequent, where during certain years precipitation is not scarce enough to be considered inadequate, especially during the summer.

Quantitative data regarding precipitation occurring in the central portion of Tibet, however, is not available.

Western Tibet is the extreme and highest part of Central Asian non-draining basins. Eastern Tibet, on the contrary, drains into the ocean. It is drained by the great Asiatic rivers such as the Yangtze, Mekong and Salween. The level of precipitation here is considerable, the Indian monsoon penetrates into this area yielding its moisture to the mountains of Eastern Tibet. In this portion of Tibet the rivers flow through grandiose eroded gorges, their sources moving farther to the west, thereby diminishing the non-draining regions of Tibet. Primary significance here is assumed by the processes of erosion which play a great role in the present day moulding of the relief of the eastern part of Tibet. As known, the indicated rivers all empty into the ocean; they deepen the valleys, carry away masses of loose matter beyond the borders of Tibet, and thereby increase the difference between the positive and negative relief features. It therefore follows that Eastern Tibet is a peripheral area of Central Asia.

Southern Tibet applies to the peripheral area as well, which is irrigated by the Tsangpo (Brahmaputra) river and the upper courses of the Hindus and Satlledge rivers, that have united Southern Tibet and Northern India into a hydrographic whole. These rivers have reached beyond the borders of Central Asia relatively late, having etched a gorge through the Great Himalayas.

In separating Tibet into regions many writers also differentiate northern Tibet, i.e. Kunlun, Tsaidam and the Koko Nor area and the Burhan-Buddha mountains. A description of them was given above, we attributed them to Central Asia proper. Kunlun forms the northern border of Tibet, its high threshold, which abruptly descends to the deserts lying below, in Central Asia proper, similar to the Himalayan mountains that form the southern border of Tibet and are a high barrier on the other side of which extend fertile lowlands of northern India. As noted above, Tibet is genetically associated both with Kunlun and the Himalayas.

Tibet, therefore, is composed of three parts that differ in their landscapes: the Western, Eastern and Southern Tibet, a brief characterization of which is the subject of the following discussion.\* (\*Even though the geographic study of Tibet has to a great degree been accomplished by Russian travellers, there are still very few generalized works on the geography of this country

in the Russian language. The most comprehensive description of Tibet is a monography written by N.V. Kyuner called "Description of Tibet", the first part of which is devoted to a geographic description and the second edition of the first part is devoted to its physical geography (Vladivostok, 1907), which was used in characterization of the regions of Tibet.)

#### Western Tibet.

Western Tibet borders approximately along the 92° meridian on the east, where the sources of the great Asiatic rivers are located. This great non-draining area is the point of origin for our commonly accepted concepts of Tibet in general, as a somber and cold upland area, predominated by high lying craggy deserts. Western Tibet is crossed by relatively low mountain ranges that split the wide, slightly tilted and generally plain shaped deserts, the surface of which is frequently covered with a shield of pebbles or alkali soils.

The Tibetan name for this part of Tibet is Chang Thang (Bzhyan Thang), i.e. northern plain, similar to the name given to it by the Mongols -- Barun-Tala or western plain. The relief here, however, may not be classified as that of a plateau, as the mountain ranges interrupt the appearance of these plains.

The morphological peculiarities of Chang Thang are as follows: the mountain ranges do not have the abrupt Alpine shapes here, gentle, levelled types of relief with table-topped features, the mountain slopes, by comparison with the peripheral ranges, are gently sloping and only slightly eroded. Rock deposits and boulder stones are quite widespread here which, as a result of the very dry conditions, are virtually immobile. The depressions between mountains are composed of great masses of loose deposits, which are conducive to rapid absorption of the river waters that flow into the foothill plains. The border mountain ranges of Chang Thang bear all the signs of young orogenetic uplifting; they are abruptly shaped, with steep slopes and their absolute altitudes are very great. The latter include ranges of the Kunlun mountain systems as well as those of N'yenchen-Tangla, Kaylas, and Gandysyshang (Trans-Himalayas).

The vegetation of Chang Thang is very scanty, and only part of its area is used as grazing land. In spots completely infertile and stony deserts strike the travellers with their somber appearance.

The landscapes of Western Tibet are known to the local population as "thang", which means "plain".

A distinguishing feature of Western and central Tibet is the presence of a great number of small and average sized lakes, that essentially determine the landscape of this portion of the upland area. These lakes are for the most part salty, some fresh water lakes are, however, encountered; they are draining lakes inter-

connected with canals and small rivers. The latter type of rivers are short and shallow. The Tibetan lakes are, as a rule, shallow; the depth of some of them, it is true, is still undetermined, but the Ligten lake in the northwestern area turned out to be too deep for sounding by a 67 meter long water gauge.

The lakes are found in the sunken areas of the Tibetan plains and are situated at altitudes of from 4,400 to 5,500 meters; they extend in a longitudinal direction parallel to the ranges and along the broad plains that are located between the mountains. The water level of the cited Lake Ligten is at an altitude of 4,898 meters, and the biggest non-draining lake of Tibet, Namtso (Tengri, in Mongolian) covers an area of 1,800 square kilometers and is located at an altitude of 4,627 meters. The mountains that traverse the plateau, however, rise to altitudes of from 5,200 to 6,400 meters, rarely higher.

It is interesting to note that almost all of the Tibetan lakes have no large inflows. They are supplied with water from the melting snows and glaciers and receive the temporary and permanent streams that deliver very little water to them, despite the fact that the area covered by some of the lakes is very great and is measured not in hundreds but in thousands of square kilometers. The lakes found in the high plains of Tibet are residual in nature, but irregardless of the fact that the rate of surface evaporation there is very low they have managed to accumulate such great reserves of various salts that they sometimes form continuous salt flats, which is why the Tibetans call them not "po" -- a lake, but "tsvaka" meaning a salty well.

"The accumulations of salt by the lakes frequently achieve great dimensions; the blinding white crust of salt is broken up by the wind into balls and pyramids, which appear more like the product of human hands than the result of natural phenomena, or into smaller pieces which are borne along the countryside in the form of a whirling white cloud." (N.V. Kyuner, 2d issue, 1907, page 52.) Mineral streams, both hot and cold, and active geysers are frequently seen in direct proximity to lakes. Hot geysers are active by the Tengri-Nur lake *(See Note)*, they provide sulphurous water that has a temperature of 84°, the water gushes up to a height of 10-12 meters. During severe winters the sight of such hot springs is quite striking, the local inhabitants keep warm by staying close to such springs. Some of the hot springs fail to survive the long and severe Tibetan winters and freeze forming cupolas of ice which are penetrated by steaming streams of warm and hot water. The hot springs of Petin erupt in streams of boiling water up to a height of 15 meters and form a beautiful panorama of 11 gushing geysers. Great popularity with the population is enjoyed by the medicinal waters of Damchou, which are situated within 110 kilometers to the north of Lhasa.

*Note* The full Tibetan name of this lake is Bzhyan-nam-tso ch'yid-mo, and the abbreviated version is Namtso. The Chinese name,

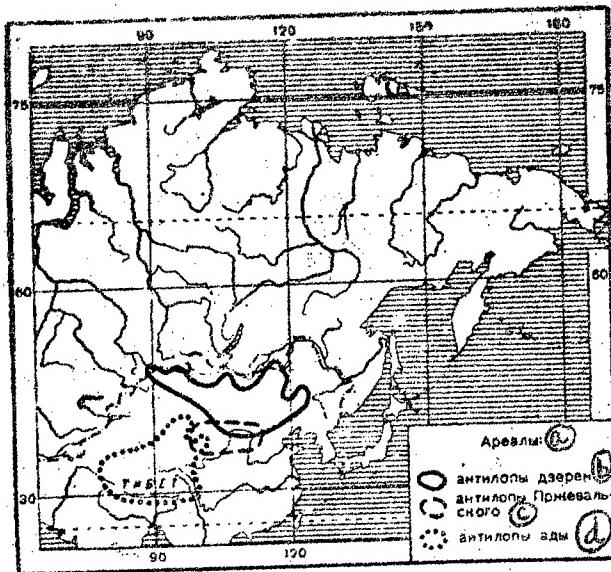
Tyankhai, has the same meaning as the Mongolian name Tengri-Nur, i.e. Heavenly Lake.

Almost all the travellers note the vivid traces left by the previous high level of the waters of the Tibetan lakes; these traces are frequently found at heights of 100-200 meters above the present water levels. The presence of salt flats or lakes that have almost disappeared from the Tibetan plains led to the conclusion that Tibet is presently undergoing a stage of dehydration. Like all of the non-draining natural water reservoirs, the Tibetan lakes are experiencing considerable fluctuations in their water levels that depend on the climatic conditions of a given year or a number of continuous years. Traces of higher water strands of the lake waters is a clear substantiation of a great increase in dryness and arid conditions during the Quaternary period. A thought, expressed by Richthofen, regarding the fact that the origination of the Himalayas on the southern borders of Tibet created a desert in the western part of it, easily explains the causes of such a rapid dehydration of Western Tibet during the Quaternary period. Moist winds are now unable to surmount the imposing parallel ridges of the Himalayan and Karakoram mountains; the winds leave their moisture on the southern slopes of these mountains.

The reconstruction of the Tibetan landscape at a stage when the waters of its lakes were at a high level allows the discussion of a radically different geographical appearance that existed in the past. With high lake water levels and generally low lake shores, the area covered by the Tibetan lakes was much more extensive than that of the present epoch; this, therefore, permits the assumption that the region that is presently Tibet contained several great natural fresh water reservoirs.

It is important to note that during that epoch Western Tibet was not a non-draining area and that drainage existed. The presence of large areas of evaporation and a considerable influx of precipitation from the direction of the Indian Ocean, assured a different circulation of moisture in Western Tibet. The occurrence of the Himalayan mountains brought about the dehydration of Tibet, a drop in the water level of its lakes, and a sharp decrease in the area occupied by them, as well as their isolation and as a result of that the mineralization of their waters. The arid processes became dominant in this cold and dry desert.

The climate of Chang Thang is characterized by considerable dryness. The amount of precipitation is negligible and does not exceed 200-250 mm annually, the greatest amount of which occurs during the three summer months: June to August and, despite that, in the form of snow. It is so dry during the winter that the fresh snow rapidly evaporates without moistening the soil; therefore, during the winter winds frequently cause dust storms. Under conditions prevailing in Europe, the role of the wind as a denudation agent is quite negligible; under the conditions in Tibet, however, quite contrary conditions exist and the wind is an important



Distribution of the Mongolian gazelle, the addax antelope and Przheval'skiy's antelope. (According to A.G. Bannikov.)

Legend: a. The areas. b. The Mongolian gazelle.  
c. Przheval'skiy's antelope. d. The Addax antelope.

cause of denudation. The summer in Chang Thang is short, with the usual night frosts and even occasional below freezing temperatures. The autumn is a relatively good time of year, dry, with some sunny days; but the autumn is also of short duration and October is already a winter month with low temperatures, cold winds, the water becomes covered with ice, the swamps dry out, and the rivers enter their fixed borders.

There are no wooded areas in the western portion of Tibet. Some bush is encountered along the banks of small and infrequent rivers: the sea buckthorn and reamyuria. The usual vegetation of Tibetan marshy lowlands consists of coarse cobresium bush that creates a durable sod layer; it appears in the form of small knolls on the surface of the soil. The animals readily consume the sedge (*Carex moorcrofti*) as well as the meadow grass and sheep's fescue. Vegetation in the western part of the Tibetan Plateau consists of a very limited number of varieties: there are only 53 varieties of blooming plants, 10 of which are endemic.

A short vegetative period is characteristic for Tibetan fauna, with an abundance of solar warmth, exceptional persistence

of below freezing temperatures and their adaptability to the great changes in temperatures that occur during a 24 hour period there. Russian travellers have observed some frozen flowers in the early morning in the mountains, but with sunrise these flowers thawed out and showed renewed signs of life.

The late spring in Tibet, the extremely low temperatures that are characteristic for May, lead to conditions where the vegetative period in Chang Thang begins only by the middle of June. Most of the plants in Tibet are perennial; they are grown relatively far apart, have a very extensive root system, are low to the ground and develop not vertically but horizontally along the surface of the ground. In general, the Chang Thang landscape may be characterized as a high ground cold desert.

The meager quality of Tibetan flora, besides the unfavorable environment, is also explained by the relatively young uplifting of Tibet and its glaciation, as a result of which the vegetation was preserved in a limited assortment of varieties only, and then evolved anew but only during the second half of the Quaternary period; after glaciation, vegetation was spreading from a southeastern direction. Typically Central Asian varieties of flora play a relatively minor role in Tibet, which is why the vegetation of Tibet is on the whole closely tied with that of China. The Tibetan and Himalayan flora was principally migrating from the elevated areas of southern China -- from Yunan.

The fauna of Western Tibet, under the severe living conditions and the barren environment that exist there, is likewise not distinguished by a great variety of animal species, but is striking in the abundance of the existing species, particularly hooved animals. The kiang (wild ass), wild yak, the Mongolian gazelle and the addax antelope, mountain goats koko-yaman, and the big argali as well as the musk deer all abound. According to its fauna, Tibet is on the whole ascribed by the geographers also to the Himalayan-Chinese subarea of the Paleoarctic region; it is frequently classified into a special province, where the influence of typical Central Asiatic (Mongolian) varieties is seen.

The majority of the wild inhabitants of Western Tibet -- are representatives of the steppe and desert-steppe varieties of fauna. Antelopes, and onagers which easily cover long distances in search of better grazing lands, are found to a limited extent. The extremely cold temperatures and the long winters force some of the animals, who do not under other conditions burrow into the ground, to build themselves deep underground quarters. Such animals are the fox, weasel, marten and the rabbit. Rodents are common in the northern and the central portions of Tibet, the most numerous of which are the marmot badgers and tree creepers. Przheval'skiy described the bear

that hunts the tree creepers, excavates their holes, and feeds on the small animals.

The most remarkable animal found in Chang Thang is, of course, the wild yak. The Tibetan upland area is the only place in the world where it has been preserved, whereas the domesticated yak is found in many other regions: Tibet, Pamirs, T'ien-Shan Altai, Hangai, Sayan, Hentai and Nan Shan.

Przheval'skiy describes the wild yak in the following manner: "This is a magnificent animal which is truly striking in its size and beauty.... The body of the described animal is covered with a dense and coarse coat of black fur, which on the older bulls acquires a dark brown tinge on the back and upper part of the flanks. The lower part of the body, like the tail, is covered with long black hairs that hang down like a wide fringe. The fur around the snout contains streaks of white, which covers the entire upper portion of the body in the young animals; a narrow silver strip extends along the back of some of these animals...these animals possess great strength and have a very good sense of smell, but their senses of hearing and sight are very poorly developed." ("Mongolia and the Country of Tanguts", Moscow, 1946, pp. 255-256.)

Rodents are common in Chang Thang, as in the other high altitude desert. This relates to a group of small animals that are active during the day, as the below freezing temperatures during the night limit the extent of their daily activities. Tree-creepers are very noticeable in Tibet, and four different varieties of them are found there. In places they are landscape animals that alter the surface of the ground with their burrowing and affect even the hard rocky surfaces. Field mice are also frequently encountered in Chang Thang; these are small and resemble mice, but are rather furry. Large marmot badgers are also encountered in Tibet; they hibernate in deep and forked holes during the long Tibetan winter.

The birds of Chang Thang are also found in a limited number of varieties, but are peculiar in the fact that over one half of them do not migrate, which, in the opinion of E.V. Kozlova, points out their great adaptability to the severe natural environment and the ancient origins of the ornithological fauna, which includes numerous peculiar endemic varieties. It is interesting that many of these birds nest in holes in the ground, which they construct themselves, or use the old abandoned holes bored by the rodents. Some of the typical varieties of birds found in Tibet are: pseudo jays, ground bramblings, red-billed sand-grouse, and redstarts. The large Tibetan mountain goat lives among the rocks in the mountains. The Tibetan sand-grouse, in various types, several varieties of lark, brambling (Kozlov's brambling, snow brambling, etc.), rock pigeon, and mountain geese are also found there.

## SOUTHERN TIBET

The landscapes of Southern Tibet are a continuation of Western Tibet, its irrigation by large rivers, and a lower position of the valleys created agricultural regions in the southern part with a relatively dense population. Landscapes similar to those of Western Tibet are found beyond the valleys. They, too, contain somber, cold and stony deserts with existing lakes, or lakes that have disappeared, deserts that cover the mountain slopes bordering on Southern Tibet. Such landscapes rise to a high up to the level of the eternal snows on the northern slopes of the Himalayas.

The Tibetans differentiate two types of landscapes here in this region: "dok" and "ron". Dok is a cold and inhospitable landscape composed of tall mountains with a dissected relief and bordered plateau regions of Southern Tibet. Here it is not as dry as in Western Tibet, therefore marshy areas are found in this type of landscape, that are covered with a short mountain vegetation. Dok may be generally compared with the so-called Alpine tundras. The Tibetans graze their yaks and sheep during the summer here, and in certain other areas that are shielded by the mountain ranges, on the southern gently tilted slopes as well as in wide valleys they even engage in agriculture. The type of landscape called "dok" is most common to the eastern portion of Southern Tibet, east of Lhasa and of the irregularly shaped Lake Yandok, which forms the intermediary landscape to those of Eastern Tibet.

The following description is that of a "ron" type of landscape. This word means gorge, ravine, canyon and narrow valley, but the term "ron" also means valleys, suitable for cultivation, mountainous countries that have abundant rivers and many valleys. The sources of the majority of rivers flowing off the Himalayas frequently flow through narrow valleys, splitting the region in a complex manner through erosion, such as the region situated between Shigatsze and the Yandok lake, where a dense population is noted as well as a large number of settlements.

The valleys of Southern Tibet form the most important regions in Tibet with respect to agriculture. The principal rivers here do not form wild and almost inaccessible gorges that are typical in Eastern Tibet, they are not found in the infertile and wide plains that are commonly found in Western Tibet. The valleys of Southern Tibet are up to 20 kilometers wide, and their area is used for agriculture, the soils are carefully cultivated, the fields are irrigated. According to the remarks made by one of the travellers who found himself there, Southern Tibet in its valleys is as "friendly and hospitable" as Kashmir and Nepal, it is covered with blossoming settlements and comfortable dwellings of the Tibetan nobility.

among the fields, on the mountain slopes and deep in the valleys, and the numerous tree groves" (cited from N.V. Kyuner).

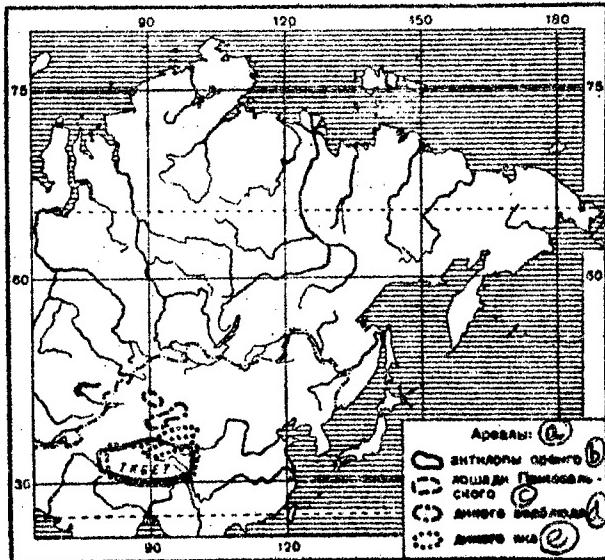
Much grain is sown in the Dzhichou valley, where the low terraces are irrigated by canals and are sown with barley, wheat, oats, polygonum, mustard and vegetables (onion, especially turnips, carrots and potatoes).

The climate of southern Tibet is much warmer than at Chang Thang due to the lower latitudes and absolute altitudes. In Lhasa the average July temperature is above  $16^{\circ}$  and during good summer days it exceeds  $30^{\circ}$ . At the same time the winter frosts in the valleys drop to  $-25^{\circ}$ , i.e. the winter here is much warmer than in the other portions of the Tibetan Uplands. Precipitation also primarily occurs during the summer, but it is much more abundant here than in the northern portion of Tibet. However, an abruptly uneven amount of precipitation is a characteristic of Southern Tibet.

The valleys of the principal rivers in Southern Tibet extend also in a latitudinal direction; they are found in the tectonic depressions that are located between the valleys. The second rate rivers that flow meridionally are short, as their basin is limited by high range watersheds. The watershed of the upper courses of Brahmaputra and Sutlej, that are located along the same latitude, is hardly noticeable and is well levelled; the absolute altitude of the watershed is 4,700 meters.

Two rivers originate in Southern Tibet and flow to the west -- the Indus and Sutlej rivers. Both of them belong to Tibet only in their sources. The Sutlej river forms two large fresh water lakes at its source -- the Manasarowar and the Rakas lakes. The Tibetans do not know of these names. The Sanskrit "Manasarowar" in Tibetan is Tso-Mapan, which means the unconquered lake; Rakas is known under the name of Lagang, or Lagran. Manasarowar and Rakas have the reputation of being "holy" lakes, that attract pilgrims. Fishing in these lakes is prohibited. One of the tall Himalayan summits towers from the south over the lakes; it is the Gurla-Mandhata, 7,728 meters tall. Manasarowar is a great lake with an area of 518 square kilometers. When it is filled to capacity its waters flow down a canal to a natural reservoir located below called Rakas, which was where the Sutlej started its long trip. At the present time the waters of Rakas almost never reach the river through the dry canal, which is filled only during the rains. But an underground contact is not excluded between the Manasarowar and Rakas lakes with the Sutlej river valley, which has its source not far from the Dalzhu monastery. The upper courses of the rivers and the lake region have achieved great popularity with the cattle breeding Tibetans, as it is surrounded with excellent grazing land.

The source of the Indus river lies in direct proximity

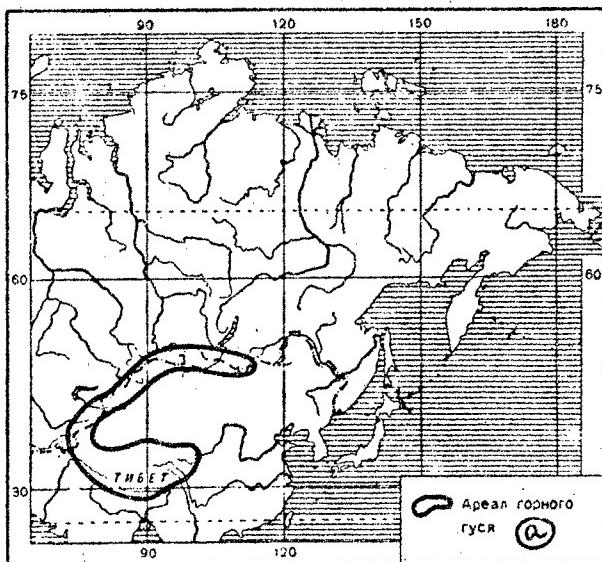


Distribution of the orongo antelope, Przheval'skiy horse, the wild camel and of the wild yak. (According to A. G. Bannikov.)

Legend: a. Areas; b. Orongo antelope; c. wild camel; d. Wild yak.

to the sources of the Sutlej and Brahmaputra rivers at altitudes in the order of 5,500 meters. The Indus flows along a broad and high altitude valley, but it is beyond the borders of Tibet that it enters into a grandiose gorge. Both of these great rivers of India have modest dimensions in Tibet. Their breadth is only 25-50 meters, and their depth rarely exceeds one meter; therefore, points where they may be easily waded across are common. On the other side of the Tibetan border these rivers, flowing through moist regions of the southern slopes of the Himalayas, become broader and fill with more water.

The principal river of Southern Tibet is Brahmaputra, or, as it is known here, Tsangpo [See Note] with a basin covering an area of 935 thousand square kilometers. From its sources it flows towards the east for a distance of 1,300 meters after which, after executing a wide bend, it flows through a deep and narrow gorge in the Himalayas and flows on towards the south, and then towards the south east, branching out in the Bengal lowland area, and emptying into the Ganges, forming a single delta with it. Tsangpo, as it flows towards



Distribution of the mountain goose (*Eulabeia indica*).  
(According to Ye.V. Kozlova.)

Legend: a. Area of the mountain goose.

the east, fills with more water and by its middle course, near Lhasa, this river may be crossed only by means of boats and jetties.

Note The names for this river vary: in Sanskrit Brahmaputra means the son of Brahma. In Tibet the names change to: Tamchok-kabab, Yayru-Tsangpo, and Dikhan. Names such as Chema-Yundung and Matsang are encountered in literature referring to this river. The Tibetan name Tsangpo means clear water, or river. The suffix "po" applies to the names of large rivers and "chou" for the small ones. This rule is, however, not always observed.

The Brahmaputra is the highest river in the world; it is navigable at absolute altitudes of over 3,500 meters. Navigation within the borders of Tibet is limited to a comparatively narrow portion of this river as Brahmaputra flows into the Himalayan mountains forming a narrow and deep gorge, inaccessible even for the smaller vessels.

Certain geologists consider that the Brahmaputra valley is an eroded intermountain hollow that split up the Himalayas and the Trans-Himalayas. Even if the effects of erosion are great here, it is impossible to deny the significance of tectonic factors, which determined the widely extended structure

of the principal orographical lines of Tibet.

On the left tributary of the Brahmaputra is the Dzhichou river /See Note7/, and the holy city of Lhasa, the capital of Tibet, is located at an altitude of 3,630 meters. The second capital is the city of Shigatse, which is located in the valley of the Brahmaputra river itself at an altitude of 3,734 meters, at the mouth of the right tributary called Nangchou, where the river flows at the rate of almost 1,000 cubic meters of water per second.

/Note7/ In Tibet, particularly in Eastern Tibet, a great majority of the rivers bear names which include the word "chou". Chou, shui -- in Tibetan and Chinese means "water". It is interesting to remember the many rivers in the USSR the names of which also include this word: Chou T'ien-Shan, Chou Altai and many others, as well as the river Szechwan in China.

Due to the low latitudes at which the city of Lhasa is located, as well as the protection afforded by the mighty N'ienchen-Tangla range (7,088 meters) on the north, the valley surrounding that city represents an area covered with cultivated plots, where wheat, barley, peas and many other vegetable crops as well are being cultivated. It has been noted that the city itself contains peach and orange trees that, it is true, do not bear fruit, some of the Persian walnut trees have also been noted there. East of Lhasa, the Tsangpo river valleys as well as those of its tributaries are used for agriculture at an increasingly greater rate. Every patch of arable land is cultivated here. Bread grains and fruit are grown there, in addition to apricots, pears, as well as nuts. Picturesque agricultural scenery found in the eastern portion of Tsangpo is compared by N.V. Kyuner with the landscapes of Kashmir. The Brahmaputra valley, which has for a long time represented one of the more important parts of Tibet and of its history, is an entographical nucleus.

The Brahmaputra valley below Shigatse is covered with plowed land; the vegetative period here lasts between 120 and 140 days. The sowing is done during April, and the crops are harvested during September. In order to accelerate the melting of snow on the fields, the snow is sprinkled with earth. Tsangpo is the most widespread crop, it is a type of barley; and wheat, beans and hemp in the somewhat warmer places. The amount of grain produced in Tibet, however, is insufficient to satisfy the needs of the population. Wheat is imported from Nepal and Bhutan wool, leather, pantothemics, mucus and objects of the Buddhist cult.

The most significant lake in Southern Tibet is the Yamdok, which is a non-draining basin. This lake contains salty water and is located at an altitude of 4,514 meters. Lake Yamdok has an abundance of fish, which the Tibetans catch and export for sale to the nearby monasteries. The vicinity

of this lake is used as grazing land for horses.

There are no forests in Southern Tibet, the western portion of which in its desert and semidesert landscapes differs little from the plateau of Western Tibet. Farther towards the east, where the amount of precipitation increases, wooded areas begin to appear along the river valleys. Only one variety of poplar is infrequently seen in the west, which grows to the dimensions of a bush in that region. The false-tamarix, Indian tamarisk, the common sea buckthorn reaches high up into the mountains (5,000-5,200 meters); above that level Alpine flora may be seen, such as the bistort, winterfat and the rock jasmine.

In the east the vegetation is more varied. Juniper, two types of poplar trees, willow trees, as well as sea buckthorn, barberry, pea tree, cinquefoil and other plants are quite common. Over 500 different plant varieties have been recorded in Southern Tibet.

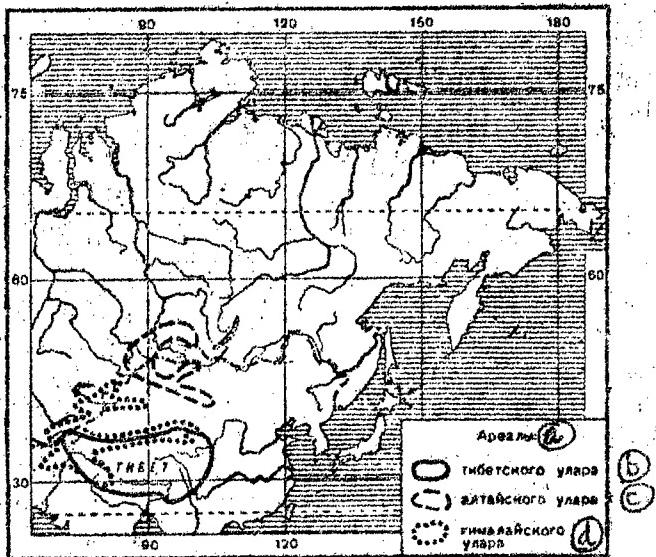
The same varieties of fauna found at Chang Thang form the predominant part of the fauna of Southern Tibet, but far from all of the animals characteristic to Western and the northern parts of Tibet descend into the Brahmaputra valley. The yak, for instance, is unknown in the Lhasa region. On the other hand, certain species common to the Himalayas and India appear in Southern Tibet.

Southern Tibet is inhabited by various species of antelope, the leopard, the same variety that is found in Iran, the Himalayas and the mountains of China, the jackal, the black Himalayan bear, who is widely found in the mountains of Southern Asia and who is encountered in the east up to the Sihotey-Aling range. The wild yak is again found in the Himalayan mountains, who seeks out the most isolated, inaccessible slopes covered with meager grazing land, below the snow line.

The number of different varieties of fauna encountered in Southern Tibet is twice that found in Chang Thang. A number of species alien to Central Asia but typical for the Alpine and the Sub-Alpine regions are found in the Himalayan mountains. The feathered population of the brush thickets in the Brahmaputra valley and of its slopes and wooded groves is a particularly distinguishing peculiarity. Some 109 varieties of birds are found in Lhasa, for instance. There is a certain homogeneity in the fauna of Southern Tibet, not only with the animal world of Chang Thang, but that of Eastern Tibet as well.

#### EASTERN TIBET

This region of Tibet [See Note 7], is the most complex in its morphology, hydrography and vegetation. Many of those who visited Eastern Tibet describe the picturesque quality of its



The distribution of the Tibetan, Altai and Himalayan mountain pheasant.

Legend: a. Areas; b. Tibetan mountain pheasant; c. Altai mountain pheasant; d. Himalayan mountain pheasant.

mountains, gorges and the grandiose scenery, which have no equal anywhere else on the extensive territories of Central Asia.

Note Eastern Tibet, south of the Yangtze and Hwang Ho watershed, is called Kam, a name that was introduced into Russian literature by P.K. Kozlov. North of the above watershed is the mountain country of Amdo, which extends up to Alashan and Ordos. The enclosed plateau of Western Tibet is called the Hachi plateau.

Western Tibet is east of the 91° meridian and blends into Eastern Tibet, the cold desert upland landscapes predominate at first.

The junction of some of the tributaries belonging to great Asiatic rivers are found here, which come close together at their sources, and then fanning out to such distances that they end thousands of kilometers apart.

The following rivers originate in Tibet: the Hwang Ho, which flows to the north, the Yangtze, Mekong and the Salween rivers which flow towards the south in direct proximity to one

another, and separate beyond the Tibetan borders. Brahmaputra executes its sharp turn next to the Salween river.

At their sources the rivers flow along level or undulating plateau. There they are comparatively shallow rivers, for the dimensions they assume in their middle courses, and are separated between themselves by poorly expressed and low watersheds with gentle and levelled relief features. The Hwang Ho (Machu, Salama), the Yangtze (Murusu, Dachu, Dochu), the Mekong (Dzachu) and the Salween rivers (Sogchou, Irchou) [See Note] flow to the west, decreasing the non-draining area of Tibet and enlarging the size of their basins. The sources of the cited rivers are located at altitudes of from 4,500 to 6,000 meters in the Bayan-Hara-Ula, Tangla and Nienchen-Tangla ranges, which here stretch in a southeastern direction and are 6,000 meters tall, rarely higher (the altitude of Basudan-Ula summit which is in the Tangla range is 6,096 meters tall, the altitude of Namchabarva summit located in the spur of the Himalayan range located by a bend in the Brahmaputra, is 7,756 meters tall); on the average the altitude of this country at the source of the rivers is between 4,500 and 5,000 meters, and some of the passes across the ranges, as a rule, are located above 5,000 meters. The cited ranges are covered with eternal snow as well as with glaciers; the snow here does not cover the slopes in a continuous blanket, but is found only to separate protruding summits.

[Note] In Tibet as well as in all of Central Asia the name of a single river varies, depending upon its merger with some tributary or a change in its course, the type of valley, or for other reasons. Therefore, only the commonly accepted names are given below, in this case the local Tibetan names are cited.

E.V. Kozlova cites the following characterization of the climatic phenomena of Eastern Tibet in the area adjacent to the upper course of the upper course of the Yangtze and the sources of the Yellow river: "...at altitudes of from 4,000 to 4,500 meters above sea level the spring starts late, by the middle of June. At that time there is no verdure; some plants, however, are already blooming (for example, the adonis, spurge, bushes of false tamarix and others). The Hwang Ho river is freed of ice at its upper course, but in the mornings sludge still floats downstream. By the end of May the black necked crane begins to lay its eggs. By the middle of June the steppe lark, the mountain finch and the plover rear their nestlings. All herbivorous animals, such as the yak, the wild ass (kiang) and the orongo antelope are lean after the winter and begin to shed. The average temperature during June is +7° and that of July +8°. The lowest daily minimum for July is -5°, the average minimum temperature for July is +0.6°. The daily maximum temperatures

during June and July do not exceed  $21.5^{\circ}$ . The winter in the eastern portion of the Tibetan plateau is milder than the one at Chang Thang. The average January temperature is  $-14.6^{\circ}$  (1873). The daily maximum temperatures in December and January are frequently  $-10^{\circ}$  (there are days when the daily maximum temperatures are expressed in positive amounts), and the daily minimums are approximately  $-30^{\circ}$ . The absolute minimum during 1873 was  $-30.9^{\circ}$  (at the upper course of the Blue river, which is 4,250 meters above sea level). During an especially severe winter in 1927 the temperature dropped to  $-35^{\circ}$  at the same eastern part of the plateau, and on 26 November it was  $-55^{\circ}$  (1952, pp. 976-977).

This characterization applies to the region of Eastern Tibet which borders on Chang Thang, and represents a description of the climate, which is predominated with intermediary features, typical for the high altitude plains of Tibet and of the Kam mountain regions, which on the whole has a mild climate, but quite heterogeneous due to its irregular relief features.

P.K. Kozlov notes that the autumn here is the best time of the year, it is dry and sunny; the winter is without snow, dry and mild. The winds blow during the day, and degree of cloudiness increases in January and decreases in February. In January the night temperature once dropped to  $-26.5^{\circ}$  and during the day temperatures below zero were recorded only on four days in December and January. The ice melts rapidly in the sun during the day, the rare snowfalls are usually quite light and the snow vanishes quickly from the ground. During February the temperatures rise rapidly, the streams babble and the birds welcome the spring and the warmth with happy singing ("Mongolia and Kam," 1905, pp. 260-261).

A "gan" type of landscape is a characteristic of Eastern Tibet. It consists of a mountainous dissected relief with areas of dry high altitude plateaus. The vegetation of the gan is more abundant and variegated than that of the other Tibetan landscapes. Fine steppes are seen here, as well as shrubby thickets and even dense forest areas. The gan sceneries vary and are picturesque.

Farther towards the south and east the average altitude of this region becomes lower, the landscape of west Tibetan uplands disappears along with the lakes. N.M. Przheval'skiy points out the striking change in the relief north of the Yangtze. From the flat watershed between the rivers he found himself in Alpine country. The relief acquires a vividly expressed eroded character. Rivers enter the mountains through deep and narrow gorges, underlining the relative difference in altitudes. The ranges acquire a narrow, steep shape with ridges that rise high above the valleys. G.N. Potanin very aptly observed that a traveller proceeding along the road built along the bottom of the gorge will find it very

difficult to visualize the actual orography or even the principal direction of the mountain ranges, due to the complexity of the mountain and valley systems in the transitory region between Tibet and Eastern China. The rivers flow through the gorges very rapidly. All this indicates the recent origin of these segments of the riverbed and the considerable erosion by both the great and the small rivers and of their tributaries. Man inhabits only the wider parts of the gorges and the farmers' plowed lands appear here.

The river gorges are such a characteristic feature of the relief of Eastern Tibet that Word, a Tibetan explorer, in dividing the country into large regions, differentiated Kam under the title of "a region of river gorges".

The summer rains that occur in Kam are conducive not only to an increase in the waters of the great rivers, but were the cause for the development of luxuriant vegetation of Eastern Tibet. B.A. Fedchenko distinguishes three botanical-geographical regions here:

1). The eastern plateau, i.e. the region at the upper course of the Hwang Ho and the flat watersheds of this river and the Yangtze, as well as at the sources of other rivers of Eastern Tibet. This region is characterized by the development of a predominantly grassy vegetation, namely of sedge, herbs, cobnut and certain varieties of bushes.

2). The region of river gorges -- the upper zone located at altitudes of between 3,000 and 6,000 meters, where at the high altitudes the vegetation still bears Tibetan characteristics. At the lower altitudes, however, the mountains are covered with fir forests, juniper and poplar trees are common. Beyond this forest belt are rhododendrons.

3). The lower portion of the region of river gorges is situated at altitudes of from 1,500 to 5,500 meters [See Note] and bears clear signs of a sub-tropical Indo-Himalayan flora. The Indian pine grows on small elevated areas, as well as magnolia, the banana-shrub, and apparently, fir. The high belt here is also represented by Alpine vegetation. P.K. Kozlov observed a great variety of plants along the large river valleys (such as that of the Mekong river), from rhododendron, fir and various shrubs, to luxuriant grasses.

[Note] The last figure will be correct only for the extreme southwestern corner of Western Tibet, where the vertical belts rise due to an abundance of warmth and moisture.

For a characterization of the landscape of the region of river gorges (of Kam) in conclusion let us cite a vivid description, given by this author during the 1889-1901 expedition.

"To the south, beyond the range, that divides the basins of both the great rivers of China, the terrain characteristics change abruptly: tall mountain chains rise towards the blue firmament, between which is found a deep labyrinth of gorges

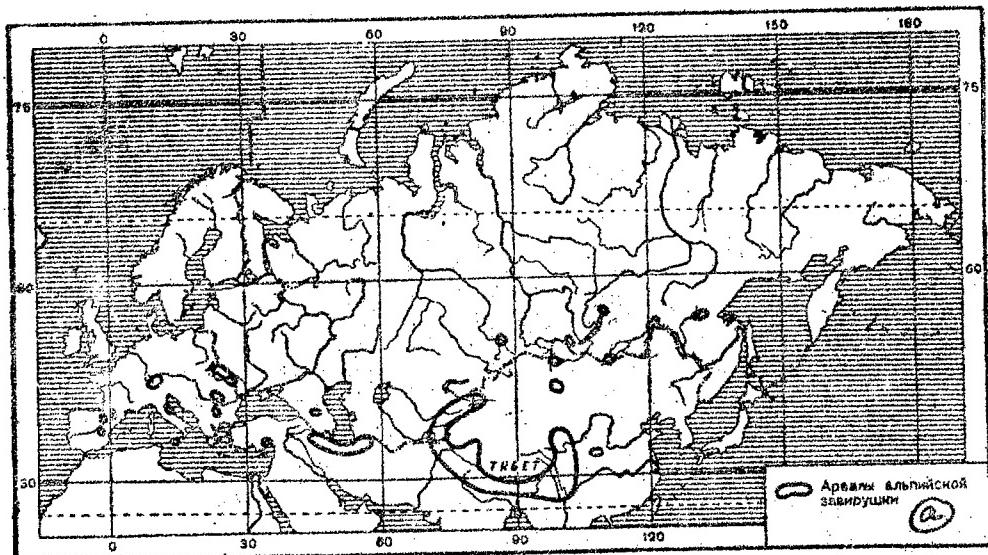
containing rapidly flowing rivers and springs. As the traveller descends lower he is still further impressed with the beauties of nature; finally man appears, first a nomad and then a farmer....

...The basin of upper Mekong appeared to us in an even more eroded condition. Here the ridges of the principal ranges and secondary mountains lie in comparative proximity to the rivers and streams that skirt them and which are for the most part enclosed in deep gorges and picturesque narrows, filled with a never ending sound of rushing waters. The wild cliffs blend into a beautiful, marvelous harmony, and are covered in spots with splendid rhododendrons, and beyond with fir trees, juniper and willow trees; wild apricot, apple and red and white mountain ash descend to the river banks below; all this is intermixed with a mass of the most varied type of bushes and high grass. In the Alps the blue, light blue, pink, and violet fields of forget-me-nots, gentians, corydalis, woodbetony and saxifraga beckon to the traveller.

The deep gorges that seem to be hidden away in the tall mountains are inhabited by beautiful multi-colored panthers, certain varieties of cats, bears, wolves, foxes, large and small volant squirrels, polecats, rabbits and small rodents, Siberian stags or deer, musk deer, the Chinese goat or dzhara, and monkeys, which we did not observe elsewhere, and which were living in large or small colonies often in the closest proximity to the Tibetans." ("Mongolia and Kam", Vol. 1, part 2, 1905, p. 259).

The influence of tropical fauna of India is felt in the southeastern part of Tibet. It is possible to see the southern variety of the wild pig in the bush, the tiger is quite common here, the otter, a clever predatory animal, inhabits numerous rivers, and the forests, especially bamboo forests shelter the peculiar Tibetan bear -- the large panda. He is encountered in wooded areas at altitudes of from 1,500 to 4,000 meters. This bear is black and white in color. The white snout has a sharply differentiated black eyes and ears. The large panda is not a predatory animal; he feeds on vegetation and especially likes the young bamboo shoots. The panda is endemic to the forests of Eastern Tibet.

Among the birds we will not see certain Alpine varieties that avoid the Tibetan Uplands and inhabit the edges of the mountain structures: Nan Shan, Szechwan mountains, the mountains of Eastern Tibet, the Himalayas, Karakorum and Hindukushu. Such birds are the ibis, the white breasted pigeon, the red brambling (*Ibidorhynchus struthersi*, *Columba leuconota*, *Pyrrhospiza punicea*). The Himalayan brambling and the Alpine hedge sparrow (*Leucosticte nemoricola*, *Accentor collaris*) are the more widespread species; the latter is found in Eurasia, from Spain to the Amur, it is strictly limited to



Distribution of the Alpine hedge sparrow -- *Accentor collaris*. (According to Ye.V. Kozlova.)

Legend: a. Areas where the Alpine hedge sparrow may be found.

mountainous regions. The largest continuous area where it may be found encompasses the Nan Shan mountains, those of Eastern Tibet, the Himalayas, Hindukush, Pamirs and T'ien-Shan. The cited typical Alpine varieties are absent from the Tibetan high altitude deserts and mountains that traverse them. (Ye. V. Kozlova, 1952, pp. 1,023-1,025.)

P.K. Kozlov writes of the wealth and diversity of feathered fauna in the southeastern portion of Tibet. That area is inhabited by white eared pheasants, woodpeckers, hedge sparrows and many other varieties of sparrows.

"During clear weather a naturalist or any person who is responsive to nature can simultaneously satiate both his sense of sight and hearing in the beautiful spots of the Mekong basin. Flocks of pheasants which strut freely and proudly, or the griffons and eagles smoothly floating in the blue sky without moving their wings involuntarily rivet one's attention; the singing of the small birds coming from the bush pleases the ear." ("Mongolia and Kam", 1905, p. 260.)

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## EASTERN ASIA

### THE NORTHEASTERN REGION OF ASIA BEYOND THE BORDER

#### A General Survey

The northeastern region of mainland Asia beyond the border includes the northeastern provinces of China as well as Korea. According to its geographical position, it is the northern portion of continental monsoon Asia, which is distinguished by the fact that it is predominantly affected by a moderate monsoon climate, despite the southern latitudes it occupies. The extreme southern portion of Korea only (south of 36° S. Lat.) is subtropical. All subtropical landscapes disappear north of that latitude due to influence of the severe continental winter monsoons, as well as that of the cooling effect of the cold Pacific current in the Sea of Japan.

The northeastern portion of China occupies an extensive region approximately 1,500 kilometers across and 1,470 square kilometers in area, which is an area larger than France, Italy and Spain combined, and twice as large as the Ukrainian SSSR. Korea extends 1,000 kilometers at its longest point and is 200-300 kilometers wide; it covers an area of approximately 221 thousand square kilometers, which is only a little less than that occupied by Great Britain (224 thousand square kilometers) and is larger than all of the republics of Soviet Trans-Caucasia combined.

The word "Korea" originates from the name of one of the ancient dynasties that held power on the peninsula, -- Kore" (Kao-li in Chinese). It was introduced into Europe by the Portuguese. The Korean name for the country, Choson, translated into Russian, means "country of the morning calm" or "the country of the morning freshness".

The name of a historical province "Manchuria" is frequently used to designate a large area of the northeastern part of China, which is firmly ensconced in literature, maps, and in physical-geographic terminology (the Manchurian plain [Sung-liao], the Manchurian-Korean and Eastern Manchurian mountains, the Manchurian flora province and many others.)

The nationality formerly occupying this territory was known as Manchurian and was close linguistically to the Tungus peoples of Siberia. In 1644 the Manchurian conquerors subjugated China, but subsequently this nationality dissolved completely among the many millions of migrants from China.

The northeastern provinces of China (Tung Pei) -- form an inseparable part of the peoples' democratic China which is building socialism, one of the richest and the most highly industrially developed part of this region. Industrial production already exceeded 50% of the overall national economy. Heavy industry is concentrated here; agriculture is also well

developed here.

The Korean Peoples' Democratic Republic (KNDR) originated in the northern portion of Korea, which also is building socialism and restoring its national culture.

Administratively Korea is divided into 14 provinces, the names of which are frequently similar except for a division into north (pukdo) and south (namdo). The Japanese names, which have been abolished, may still be encountered in literature and are therefore given here in brackets. The following provinces are listed from northwest to southeast: North and South Pyongan (Heyan) -- Pyongan Pukdo and Pyongan Namdo, Cheju, North and South Hamgyong (Kanke) -- Hamgyong Pukdo and Hamgyong Namdo, Hawanghae (Kokaiy), Kyongii (Keyki), Kangwon (Kogen), North and South Chungchong (Tyusey) -- Chungchong Pukdo and Chungchong Namdo, North and South Cholla (Dzenra) -- Cholla Pukdo and Cholla Namdo, North and South Kyongsang (Keyse) -- Kyongsang Pukdo and Kyongsang Namdo.

The northeastern portion of China has a common border with the Soviet Union that extends for 3,430 kilometers. The border mostly passes along rivers (Argun, Amur, Ussuri, Sungacha), by Lake Khanka and along the Manchurian-Korean ranges (Pogranichnyy and Chernyye Gory). The border between Tung Pai and Korea lies within the morphologically unified system of the Manchurian-Korean mountains and along the Tumen (Tumangan in Korean) and Yalu (Amnokkan in Korean) rivers.

#### The Population.

The population of the northeastern provinces consists of 45 million persons.

Over 90% of the population are Chinese. Over 2 million Mongols inhabit the western parts of the country and the southeast is populated by over 1 million Koreans. The remainder of the population is composed of Tungusic nationalities: Tatars -- 300 thousand persons, and the others: Solons, Buriats, Evenks, Gohlds -- all comprise a group numbering 25 thousand persons. These nationalities primarily inhabit the northern portions of the country and are engaged in hunting.

Korea has a population of 30 million (1950), i.e. 135 persons per square kilometer. Out of all the Asiatic countries Korea is second only to Japan in the density of its population and exceeds that of India and China. Population is particularly dense in the shore regions (up to 250 persons per square kilometer), where over one half of the entire population of Korea is settled. The population density is lower in the mountains, and the mountain-forest regions deep in the interior are almost uninhabited. The absolute majority of the population in Korea is composed of Koreans.

Over one quarter of the entire population of the north-eastern portion of Asia beyond the border is settled in cities. The largest cities are: Mukden (Shenyang) with a population of approximately 2.5 million, Harbin -- 800 thousand, Talien -- over one million; Changchun -- 600 thousand; these cities all have a European appearance. The largest cities in Korea were modernized only in central parts. Seoul was populated by 1,114 thousand persons in 1942. Pyongyang, which became the principal city of the Korean Peoples' Democratic Republic, has a population of 388 thousand and Pusan has 326 thousand inhabitants. As a result of the war most of the cities of North Korea were destroyed. After the armistice, which was concluded in 1953, the KNDR developed extensive work for their restoration of housing and the country's economy.

The largest cities and settlements in the northeastern area of Asia beyond the border consists of one-story structures, known as "fanza" in China. Both settlements and the individual fanza are usually constructed out of clay. Wooden buildings are encountered only in the wooded mountain regions. The heat, during the severe winters, is provided by a system of flue pipes called kan, that are built in under low stove-couches that are used by the people to sleep on.

Industry, beside the largest cities, is concentrated in the South Manchurian and Tungpiantao. The northeastern industrial regions and the Seoul, Pyongyang and Sinuiju industrial regions on the west coast are the most outstanding ones.

Among the scarcely populated areas in the northern regions of China only the areas directly adjacent to important roads, rivers and gold mines have been exploited. The regions of former intensive colonization exploitation was heretofore evident in an extensive felling of forests, plowing of the steppes and the levelling of depressions located between the mountains (soybeans, kaoliang, green bristle grass and corn are the predominant crops here).

With the advent of peoples' power in China, great new possibilities for the transformation of natural conditions have come about. The Chinese people have already applied themselves to reforestation in order to protect the fields, to the construction of extensive water control dams and a network of irrigation canals.

Numerous railroad tracks and automobile highways cross China and Korea in different directions, including some of the mountainous regions.

The Chinese-Eastern and South-Manchurian railroads (KVzh and YuMzh) built by Russia have been combined under a single name of Chinese Changchun Railway (KChzh). This railway, which was formerly under the jurisdiction of both the USSR and China, was transferred to the complete jurisdiction by the Chinese People's Republic in 1952 and has a great

significance in the economy of China and its contact with the USSR.

#### Transliteration of Names.

Difficulties associated with the great diversity of geographical names, as well as with their transliteration and pronunciation, arise in the study of Korean geography.

A "Japanese reading" of the Korean names, irrecognizably different from the Korean names, occurred as a result of the forced Japanization. Many subjects also have a third and, sometimes, a fourth and a fifth name -- Chinese, Russian and English or French; the latter two languages apply to coastal cities and areas and then only in sailing directions and marine maps.

#### A Comparative Table of Korean Geographical Names

Korean	Japanese	Chinese	Russian
(See table on page 147.)			

The diversity existing in the transliteration of Korean names is associated with the difficulty in expressing a number of sounds in the Korean language with Russian letters. The same words transcribed according to different systems are completely dissimilar. "Chiangching" and "byak" come out as "dengdin" and "pek" when transcribed by means of another system.

In studying Korea the following alternative interpretations should be kept in mind: a nasal "n" is expressed in three ways: "ng", "n'" and "n". In writing it is preferable to use "n'" or "ng" as "n'", especially in the middle of words and preceding vowels, appears incomprehensible ("Kan'ge"). An uninformed reader does not take into consideration the letter at the end of a word and reads a name like "Khamkhyn'" as "Khamkhyn". The syllables "pkho", "pkhe" are sometimes written as "po" and "pe"; "uyen" instead of "uon"; "rien" or "rieng" instead of "ren"; "tszyu", "chyu" or "dyu" instead of "chzhyu", and so on.

It is important to remember the meaning of the following Korean words: san -- mountain; gan (gang, kan) -- river; chkhen, tkhen -- torrent, stream; ren -- pass; bon -- range; pkhen, uon -- plain; khe -- sea; pkho -- bay; man -- gulf; chzhu -- island; puk, buk -- north; nam -- south; se -- west; ton -- east; do -- province.

A Comparative Table of Korean Geographical Names

KOREAN	JAPANESE	CHINESE	RUSSIAN
Annokkan (riv.)	Orekko	Yaluchiang	Yalu
Tumangan (riv.)	Tomanko	T'umenchiang	Tumen-Ula
Hangan (riv.)	Kanko		Han
Kymgan (riv.)	Kinko		Kumgang
Tedongan (riv.)	Daidoko		Taedong
Naktongan (riv.)	Rakutoko		Naktong
Hochhongan(riv.)	Kesenko		Hochon
Puchzongan(riv.)	Fusenko		-
Chanchingan(riv.)	Tesenko		Changjin
Soragon (riv.)	Tokuroko		Sürogang
Sodusu (riv.)	Seitosui		Sodusu
Chyanpeksan (plateau)			Changpai Shan
Paektu-san (mountain)	Hakutesan	Bantai Shan	Paektu-san (White Mountain)
Puchzollen (range)	Fusenrei		
Puktebon (range)	Hokudaykho		Tapai Shan (Big Northern Mt.)
Kymgonsan (range)	Kingozon		Kumgang San (Diamond Mt.)
Soraksan (mountain)	Setsugakusan		Sorak San (Snow Mt.)
Tebeksan (range)	Taikhakusan		T'aebaek San (Big White Mt.)
Sobeksan (range)	Sekhakusan		Sobaek San (Small White Mt.)
Noren (range)	Rorei		
Chkhoren (range)	Ssiariey		Chkhvorleng
Choson	Tesen	Choasien, Kao-li	Korea

The following account includes the general natural characteristics of the northeastern region of Asia beyond the border with emphasis on the northeastern part of China along with mainland Korea (taking into consideration the physical-geographic unity of the Manchurian-Korean mountains), and individually in greater detail on the Korean peninsula, the nature of which is manifestly different from the natural conditions of the remainder of the territory in many ways. Northeastern China here is understood to be a physical-geographic division and not an administrative one, as a synonym for Manchuria, i.e. with the inclusion of the northern portion of Inner Mongolia.

The landscape of the northeastern portion of Asia beyond the border contains contrasting influences of the gentle southern and the moist seacoast monsoon natural conditions, with the severe influences of the continental nature of Central Asia and Siberia. This is the coldest and northernmost portion of Eastern Asia beyond the border, with frosty winters and little snow together with rivers that freeze during the winter. Along with that part of the territory the northeastern portion of Asia beyond the border is a country with a warm, moist summer and is an area containing abundant vegetation; its territory includes the peculiar Manchurian flora region -- the center of formation and distribution of the Manchurian flora, one of the repositories of Tertiary vegetation which here survived the epochs of Quaternary glaciation.

#### The Relief and Geological Structure.

A relief clearly divided into macroforms -- several plains and complex upland areas, is a characteristic feature of the northeastern portion of Asia beyond the border. An amphitheater of mountain ranges and foothills, a plain that resembles a flat plate, called Sungliao, which is crossed by large rivers -- Sungari and its left tributary, Nonni (Nungtisan). The mountain country of Greater (Great) Khingan extends along the meridian in the west, which in the south turns into the East Mongolian plateau ledge (Yin Shan mountains), on the north are the Lesser Khingan, and on the east -- the large system of Manchurian-Korean or Changpai Shan mountains, which are subdivided, in accordance with the position of the various countries, into East Manchurian and North Korean mountains. Parallel to the southern spur of the latter, called the Paektubon range, are the East Korean mountains that fill the Korean peninsula, extend in the southeast.

The Sungliao plain narrows to 120 kilometers and faces the Yellow Sea through a corridor called the South Manchurian

plain or the Mukden lowland area. The river Liao basin is separated from the Sungari river basin only by an almost unnoticeable row of hills. The South Manchurian plain is bordered on the northwest by the Liaohsi mountain system which is a frontal system with respect to Yin Shan, and on the southwest it is bordered by the southwestern portion of the East Manchurian mountains -- the Liaotung mountains. "Liaohsi" means "west of Liao", "Liaotung" -- "east of Liao", i.e. from the Liao river.

The Sungliao plain has another exit in the northeast, formed by the Sungari corridor between the Lesser Khingan and the West Manchurian mountains, which is crossed by the middle course of the Sungari river, and leads to the Amur-Sungari (Middle Amur) lowland plain, which is partially located in the USSR. The Ussuri border corridor connects this plain with lowland pre Hankai plain which is located higher up the Ussuri river and is also partially in the USSR. The Suifang corridor in the southern part of this plain, within the USSR, leads to the Sea of Japan.

The geological structure and relief of the northeastern portion of the Asia beyond the border was formed as a result of complex processes, which occurred on the Chinese platform and in the neighboring Mongolian-Okhotsk and East-Asiatic geosynclinal regions.

The archean foundation, revealed in the Manchurian-Korean mountains, consists of gneiss, dissected by granite of the Pre-Cambrian and later ages. The remarkable metalliferous quality of these mountains is associated with these intrusions. The Proterozoic period is represented by a complex metamorphic sedimentary deposit. Upper Proterozoic non-metamorphic deposit, consisting of purely platform formations -- red sandstone, "great limestone" and shale, that falls between the Pre-Cambrian and Paleozoic periods is widespread in Northeastern China. The marine platform paleozoic matter (limestones of the Cambrian-Silurian and Upper Carboniferous periods, carbonic Permian-Triassic periods) and fresh water Mesozoic matter, analogous to the thick Baikal layers of the Soviet Far East. Mesozoic matter is insignificant and slightly dislocated on the stable sections of the ancient platform; in some of the more mobile zones it forms layers several thousand meters in thickness and turned out to be, along with the underlying Paleozoic and Upper Proterozoic platform layers, the arena for the appearance of a peculiar "intraplatform" folding. The accumulation of continental sediments continued during the Cainozoic period, along with the erosion of the Mesozoic folded structures.

The depths of the northwestern portion of China were permeated by granite intrusions up to the end of the Mesozoic period. Power basaltic effusion started from the Tertiary

period, and attained special scope during the Quaternary period, which is believed to have occurred at the time of extensive fracturing. The most widespread basaltic cover in the Manchurian-Korean mountains occupied an area of 500 kilometers long and 200-250 kilometers wide, forming the large Changchi Shan plateau.

Mesozoic movements affected the present day relief in that they established the principal characteristics of the distribution of the large features -- plains and plateaus of northeastern China. The protruding features of the second order (ranges, valleys, ledges) that arose as a result of these movements during the Mesozoic period, naturally had enough time to become more than once almost completely levelled into plains by the external forces. Remnants of surfaces that were subjected to levelling during the lower tertiary period are well expressed in the present relief.

The Cainozoic movements were also very intensive, especially at the end of the Pliocene period -- beginning of the Pleistocene period. Along with rejuvenated erosion they determined the principal features of the present relief, in the depths they had little effect (redoubled shattering and vertical differentiated movements, increased vulcanism). They represented "a compression of the weak cover of the newest formations between blocks, that were already unyielding to that type of movements" (A.N. Krishtofovich, 1932).

Lower Tertiary plains were raised, shattered or curved and deeply etched by fresh erosion to a lower basis. During the process of their rejuvenation, a passive predetermined influence of more ancient (Yang Shan) structures also became revealed, inasmuch as their preparation was progressing along with structural-lithological relationships that formed during the Mesozoic period.

According to E.E. Anert (1928) and A.N. Krishtofovich (1932), there are six basic fractures which have brought about the most outstanding features of the present relief: 1) Along the eastern slope of the Greater Khingan; 2) along the northwestern end of the Manchurian-Korean mountains; 3) along the Sea of Japan coast, along the southeastern edge of the foothills of the Manchurian-Korean mountains; 4) along the western edge of the Pre Hankai lowland area in the Suifeng corridor; 5) along the Amur above Blagoveshchensk, and 6) along the southern foothill area of the Ilhuri Alin range.

Along with these most important distributions there are many fractures of local significance. Such is the lattice of faults by the southwestern foothills of the Lesser Khingan where a remarkable region of recent eruptions of the Udal'yanchi is found; these are the numerous longitudinal fractures in the Manchurian-Korean mountains, which predetermined the complete

domination of the relief by longitudinal splitting and which served as the source for the effusion of great masses of basalt.

The Red Pleiocene clay in the southwest is covered by loess, which towards the north changes into argillaceous, pebble and sandy facies. Plains under the most recent alluvial deposits cover thick Pleistocene layers of pebbles, sand and clay, that were deposited by rivers or those in ancient lakes.

The period of glaciation was reflected in the northeastern portion of Asia beyond the border through generally cooler temperatures, an expansion of the belt of eternal congelation and the formation of small glaciers in the highest portions of the Manchurian-Korean mountains and the Lesser Khingan.

The most recent uplifting was preceded by postglacial descent of the dry land. Movements continue at the present time as well, which is substantiated by the presence of recently active volcanoes, a drop in the level of the Yellow Sea and a clear predominance of erosion over accumulation. Erosion encompassed thick layers of loess in the southwest and the Pleistocene clay and sand on the Sungliao platform. The fresh lava massifs were also subjected to strong erosion.

The northeastern part of Asia beyond the border is extremely rich in useful minerals, especially coal, iron ore and gold. The most important coal basins are located in the Manchurian-Korean mountains, in the Liao and Lesser Khingan mountains. Tung Pai is the source of over half the coal mined in China. The largest basins are the Fuhsin, Fushun and Haokangi. Other important coal fields are located at Mishan, Muleng, Hsian, Penchi, Tungpingtao, Peipiao and Chollo Nor. The coal of many deposits is processed into coke. Extensive supplies of combustable shale (Fushun) and bituminous coals are available, that are useful for the manufacture of oil products.

Iron ore fields are concentrated in the Anshan, Penchi and Tungpingtao regions, in the north of Korea -- in the Musan region. The north of the country is famous for its gold where it is found both in veins and mines; the gold veins are virtually exhausted south of the Sungari passage. Large reserves of aluminium and magnesium, and of tungsten on the Korean peninsula, are significant.

#### Climate.

The climate of the northwestern portion of Asia beyond the border is more severe than could be expected at these latitudes ( $34^{\circ}$ - $53^{\circ}$  Lat. N.) The comparison of meteorological data gathered at Harbin with those of Liao which is located on almost the same latitude, as well as data gathered at Mukden

(Shenyang) and of Tashkent, which is located within the continent, illustrate this condition.

Points	N. Lat.	Year	Average Temperature		Variations in tempera- tures of January and July
			January	July	
Harbin.....	45°45'	3.2	-20.5	23.1	43.6
Liao .....	45°42'	11.5	2.4	21.2	18.8
Mukden (Shen- yang)	41°48'	8.0	-13.0	24.7	37.7
Tashkent.....	41°20'	13.5	-0.3	27.2	27.5

Despite the proximity of the sea, the climate of the northwestern portion of Asia beyond the border is strongly continental; extremely cold winters alternate with very hot summers.

During the winter the cold continental air from Eastern Siberia flows through here forming a winter monsoon along the eastern periphery of the Central Asian anticyclone. Reaching a vertical velocity of 3-4 kilometers this air, which is carried in the northwestern current, effortlessly surmounts the border mountain chains of northwestern China and is distributed over the Sungliao plain. The winter monsoon winds are prolonged, persistent and bring cold temperatures and dryness. Little snow falls, as a rule, during the winter, which complicates the growing of winter crops and fruit trees.

The spring is long, cool and dry. Most of the snow disappears as a result of direct evaporation, before it gets the chance to melt.

Summer, in the northwest of Asia beyond the border is a moist season, during which approximately 80% of the annual precipitation occurs. The summer southeastern winds from the sea, that bring a significant amount of precipitation, are usually designated as the "summer monsoon", as contrasted with the winter monsoon. This is sufficient to call the climate of the entire country a monsoon climate. The latest data on dynamic climatology, however, indicates a more complex picture of the summer atmospheric circulation over northeastern China.

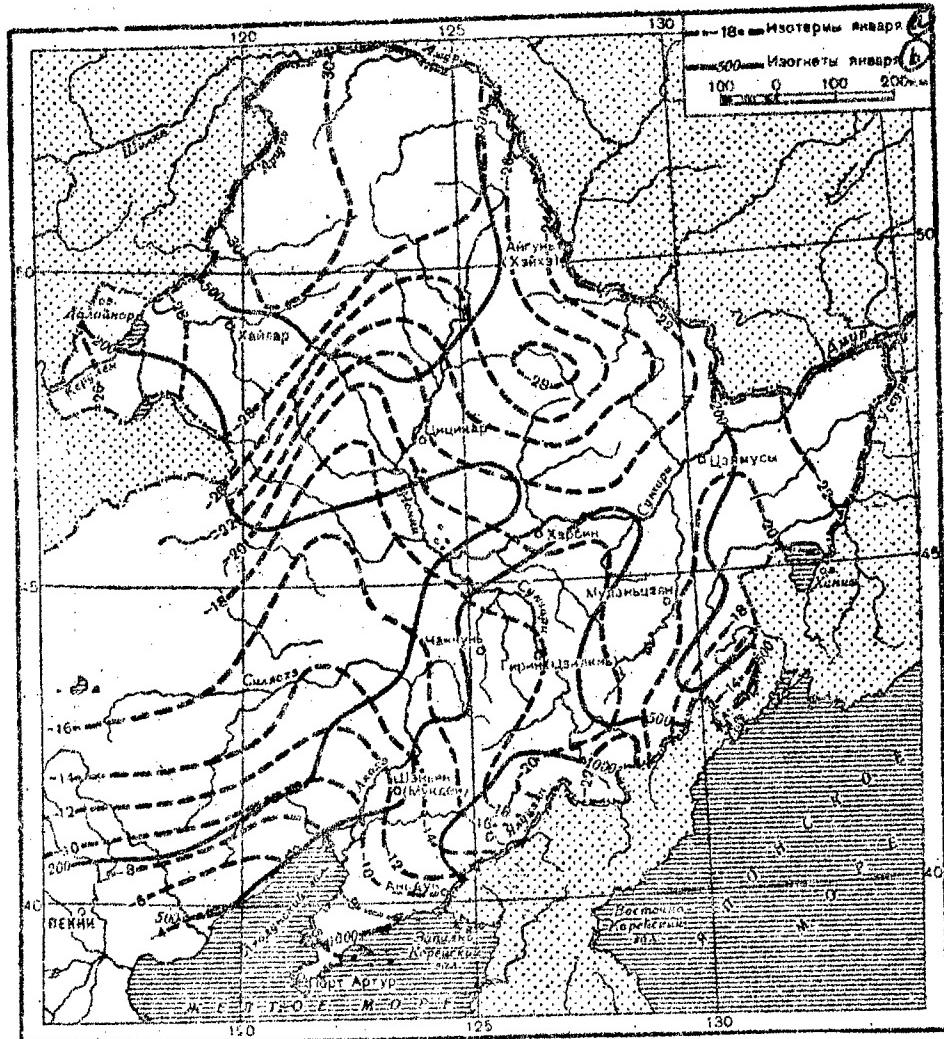
The role of cyclonic processes in the Polar region is very significant, as well as that of the southwestern and other important winds along with the southeastern ones.

The complexity of the summer climatic conditions in the northeast of Asia beyond the border greatly depends on the fact that this territory during the summer is under the influence of two types of frontal processes. One of these occurs in the Pacific Ocean Polar front, which is located in the south of Korea and the north of Japan during the summer. The cool sea air of the moderate belt comes into contact here with the warm tropical sea air. Another type of process is the interaction of the continental air masses of the moderate belt with the continental tropical air masses in the Asiatic Polar front.

Most of the summer precipitation is associated with the Pacific Ocean Polar front cyclones. During the summer the dominant air mass over the plains is the sea air from the moderate belt. Cool when it originates, this air, which has a vertical velocity of over 1-1.5 kilometers, flows over the low portion of the Manchurian-Korean mountains, becomes considerably warmer, loses part of its moisture and assumes certain features of the continental air currents.

The principal source of summer rains is not this lower air, but a warmer tropical sea air, that spreads over it in warm sections of the cyclones. The frequently observed inconsistencies in temperatures of the comparatively cool lower layer of air and the surprisingly warm rain drops is associated with this: They come from the upper warm air layer. They have more than a chance resemblance to tropical torrential rains in both their abundance and temperature. Regular and frequently catastrophic floods involving most of the country's rivers are the result of these summer rains. The hot and dry air of deserts in the interior of China sometimes penetrates into the northeastern part of Asia beyond the border in warm sectors of the Asiatic Polar front cyclones. Such penetrations are most frequent during the spring and at the beginning of summer. These intrusions are usually insignificant, as the cyclones, on their way to the northeastern part of China have time to become occluded, the tropical air is forced away from the surface of the ground by air from the moderate belt and then rushes past over it in the upper current. The intensity of these penetrations by the tropical air, however, vary considerably from year to year. If they are prolonged and strong, great droughts result, that are destructive to the moisture loving plants. It is not by chance, then, that both the moisture loving crops (soya) and the drought resistant crops (green bristle grass, kaoliang and others) are simultaneously cultivated in northeastern China.

The surplus of summer rains, however, also leads to

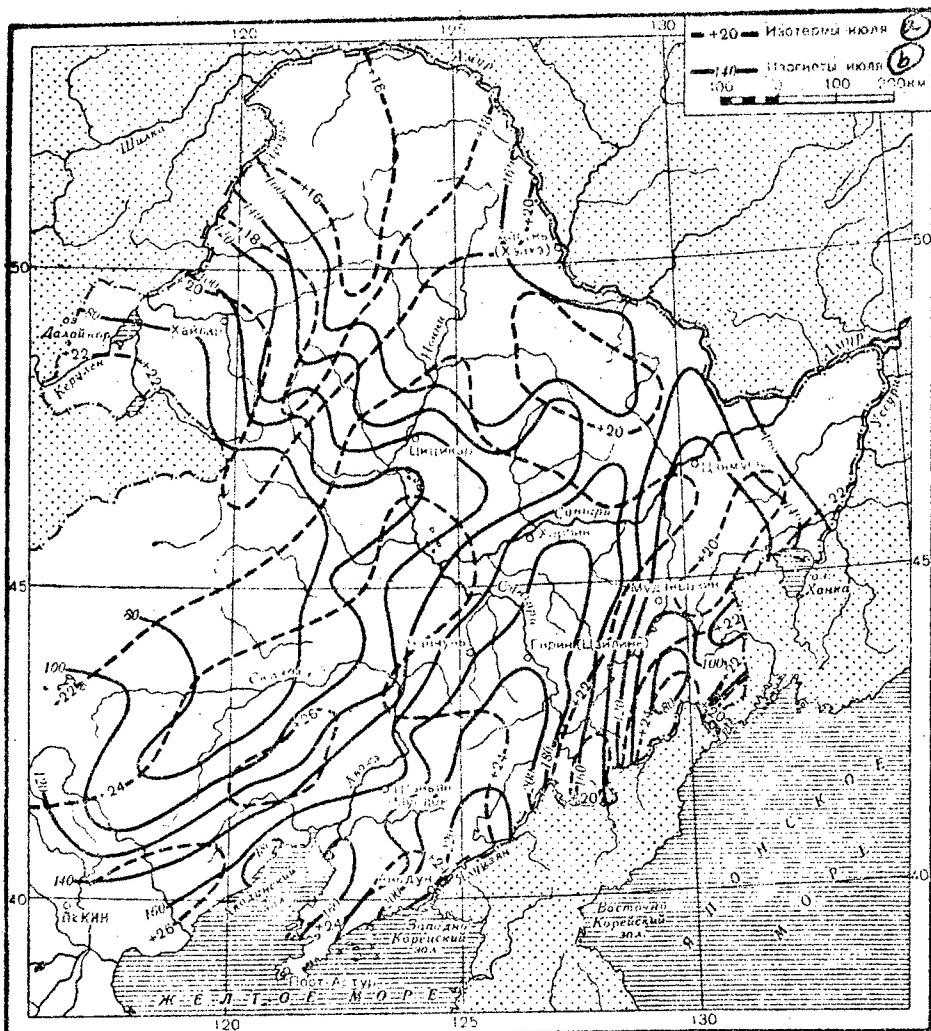


The average temperatures and precipitation patterns in the northeast of Asia beyond the border during January.  
(Compiled by Yu. K. Yefremov.)

Legend: a. January isotherm; b. January isohyet.

losses in agriculture by causing extensive floods, the loss of crops over great areas, and the flooding of hundreds of populated points. In 1932, 514 millimeters of rain fell in Harbin over a period of one month, i.e. almost as much as the usual annual volume for that area.

The duration of the vegetative period (5-7 months),

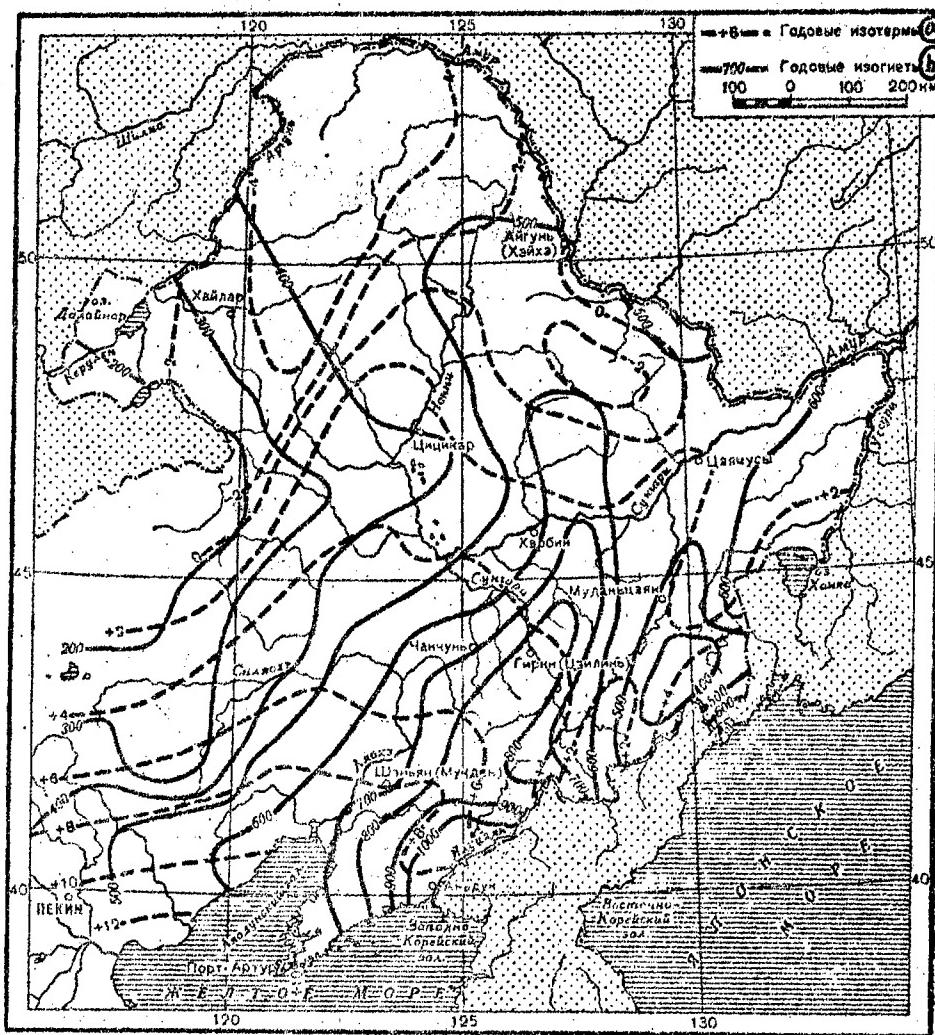


The total average annual amount of precipitation and the average annual isotherms in the northeastern part of Asia beyond the border. (Compiled by Yu. K. Yefremov.)

Legend: a. Annual isotherms; b. Annual isohyets.

with favorable precipitation and stable high temperatures are conducive to spring sowing and the cultivation of warm weather crops (rice, cotton).

The autumn is warm and dry, aside from the few typhoons (tropical cyclones originating in the Polar front), that are accompanied by hurricane winds and heavy showers which also



The average temperatures and precipitation in the northeastern part of Asia beyond the border during July. (Compiled by Yu. K. Yefremov).

Legend: a. July isotherms; b. July isohyets.

cause floods.

The size and irregular nature of the terrain result in an inconsistent distribution of climatic peculiarities. The drier climate is most clearly evident towards the west, away from the ocean, and towards the south, closer to the subtropical zone. The influence of the relief is also noticeable (the altitude climatic zoning, the difference between the more moist slopes, facing the sea and the drier slopes, facing towards the interior of the continent). The northern portion of the country is considerably colder than the southern portion.

These differences have a sharp effect on the appearance of the entire landscape, on the water, soil and vegetation, creating contrasts between the dry steppe southwest portion, moist southwestern broad-leaved forest section and the mountain-Taiga and marshy northern section with congelation.

The absolute minimum temperatures in the northern portion of the country are as low as  $-47^{\circ}$  (December-January); the absolute maximums in the southwest are  $43^{\circ}$  (July-August). The annual course of the average temperatures and precipitation at some of the more representative points is evident from the following table:

The Course of Annual Average Monthly Temperatures

Meteorological Stations	Alt. m.	I	II	III	IV	V	VI	
Hailar	609	-28.6	-24.9	-14.8	0.9	10.3	17.1	
Harbin	150	-19.7	-15.7	-5.8	5.8	13.8	19.7	
Mukden (Shenyang)	60	-13.0	-9.3	-1.1	8.6	15.7	21.6	
Dairen	10	-5.0	-3.5	1.9	9.3	15.2	20.3	
		VII	VIII	IX	X	XI	XII	
							Annual	
Hailar		21.0	18.0	9.8	-0.1	-14.5	-25.0	-2.6
Harbin		23.1	21.5	14.7	5.2	-6.3	-16.9	3.2
Mukden (Shenyang)		24.7	23.6	16.6	9.0	-1.3	-10.2	7.1
Dairen		23.5	24.6	19.8	13.6	5.1	-2.2	10.2

The Monthly Volume of Precipitation

Meteorological Stations	Alt. m.	I	II	III	IV	V	VI	
		VII	VIII	IX	X	XI	XII	Annual
Hailar	609	3.9	4.1	3.8	10.3	21.2	49.4	
Bukhedu (Greater Khingan)	705	2.1	2.0	2.1	9.6	26.2	84.3	
Harbin	150	4.0	6.2	12.1	19.5	43.0	99.3	
Mukden (Shenyang)	60	5.0	5.0	20.0	28.0	56.0	86.0	
Dairen	10	12.8	8.5	19.0	24.4	45.0	46.0	
-----								
Hailar	79.4	63.9	49.7	10.7	5.4	4.2	306.0	
Bukhedu (Greater Khingan)	110.9	89.0	57.9	8.6	5.0	1.8	399.5	
Harbin	153.1	108.1	58.4	28.2	12.9	5.0	549.8	
Mukden (Shenyang)	160.0	155.0	84.0	41.0	28.0	5.0	673.0	
Dairen	164.9	126.3	104.9	28.2	24.8	10.8	615.6	

It is evident that the annual amount of precipitation at Tungbei is most variable. By the Mongolian border it decreases to 250 millimeters and in the coastal hills it increases to 1,000 millimeters. But the characteristics of their occurrence is the same throughout, a winter almost without precipitation and a rainy summer -- from May to September (in the south until October).

### Internal Waters.

There are numerous lakes in northwestern China, both in the mountains and the plains. In contrast with the other portions of eastern Asia, beside the main summer high water (monsoon) period, there is here a smaller high water period during spring, caused by the melting snows. It is not very great as little snow falls during the winter and the direct evaporation of the snow. The river network in the dry west is very scattered; there are no large rivers; individual regions have no peripheral drainage.

The largest portion of the northeastern region of China forms a part of the Amur river basin. The principal component parts of this basin are formed by the Argun and Sungari river basins (with its large tributaries: Nonni river on the left, Mutanchiang on the right), the Ussuri river (with its left tributaries Sungacha and Muleng), as well as the region of the Chinese pre-Amur region -- basins of a number of small Amur tributaries, that flow off the Ilhuri Alin, and the Lesser Khingan: HumaerHe, SungHe and others.

An independent basin, second in importance, is formed by the Liao river. The Yalu and Tumen river basins are an important part of the Manchurian-Korean mountains, as well as that of the upper course of the SuifenHo river (its lower course is in the USSR). Small individual basins (LuangHo and others), are found along the coast of the Yellow Sea -- in the Liaohsi mountains on the Liaotung peninsula.

The large rivers are navigable. The rivers of eastern Manchuria perform an important role in the provision of the greatly expanded industry with hydroelectric energy. Extensive deforestation considerably worsened the regime of many rivers. Catastrophic floods are frequent.

The Chinese people have started extensive river control projects in Tung Pai along with measures designed to improve the utilization of these rivers for irrigation and navigation. A navigable canal between the Sungari and Liao rivers, which will combine the rivers of Tung Pai into a single river network, is in the planning stage.

There are large marshy areas in the mountains and in the northern part of the country, which to a great degree evens out the drainage regime. The only drainage regulators are the large lakes -- the plain Lake Khanka, and the lava bed mountain lake Tsinpohou.

The Sungari river (Sunghwachien) is the main water artery of northwestern China; its basin occupies approximately 50% of the country. The river is 1,525 kilometers long. The Sungari is formed by the merger of the Ehrtao Chiang and the Towtao Chiang rivers, which originate in the Changai Shan

plateau. One of the tributaries originates near Lake T'ienchi near the Paektu-san volcano. At its upper course the Sungari river is a mountain river with many rapids. A large hydroelectric power station, Tafengmang, has been constructed on it near Kirin (Tsinglin), along with a water reservoir 545 square kilometers in area. In its middle course (below the city of Kirin) Sungari flows into the Sungliao plain and becomes 0.5-2 kilometers wide and navigable. The Sungari valley below the mouth of the Nonni river is especially subject to floods. The valleys narrow in the Sungari corridor, the river here crosses the structures that connect the East Manchurian mountains with Lesser Khingan. These rapids, however, are deeply eroded and are felt only in the region of the Sanghsin shoals; on the remainder of this mountainous segment the river is distinguished by a clear channel and is quite suitable for navigation. At its lower course the Sungari flows through an unsteady and wide bed along the Amur-Sungari plain, frequently branching out, with an abundance of alluvium shoals. The width of the floodlands is 3-5 kilometers. The river is frozen from November until March.

The Nonni river (Nunkiang) -- is the largest tributary of the Sungari river; it is a big, highwater and navigable river approximately 1,200 kilometers long. Its basin is an amphitheater formed by the Greater and Lesser Khingan, where its numerous sources and tributaries originate. Up to the city of Nunkiang (Mergen), the river has mountainous characteristics and is suitable only for floating timber; below Nunkiang, however, it is navigated by junks and motorboats, and below Tsitsihar, by steamships.

The Argun river, which is the right hand river forming the Amur. This river starts under the name of Hailar in the Greater Khingan, and at first flows for 300 kilometers to the west and emerges at the Soviet-Chinese border. Here the Mutnaya channel, whose direction is inconsistent, branches off from it and connects this river with Lake Dalai Nor (Hulun Chih). This lake has a ramified basin which receives the waters of the Kerulen river from the southwest and those of the Orchung Gol from the south, the draining river of Lake Buyr Nor. Buyr Nor in turn receives the waters of the Halkhain Gol river, which flows along the border between Mongolia and China.

The Argun river acquires its name below the mouth of the Mutnaya channel; from that point the river becomes the border between China and the USSR. On the right the Argun receives a number of rivers, the most important ones of which are the Kenhe (Kang), the Haul and the Terbul rivers that irrigate the so called Trekhrech'ye region. The last 436 kilometers of the river are navigable. The river is 150-200 meters wide and becomes 300 meters wide by its mouth. The banks are mountainous,

the river bed abounds with over one hundred shoals.

The Amur river, called Heilungo Kiang in Chinese (River of the Black Dragon) or Hai He (Black River), is 2,897 kilometers long, due to the merger of its two sources, the Shilka and Argun, 1,800 kilometers of which serves as the border between China and the USSR. The river freezes from November until April; it has two secondary maximums during the snow thawing period (April in the plains and May in the mountains), and sharp summer and autumn maximums during the monsoon and taifun rains. The flood waters reach 8 meters in depth, and flooded areas are 30-40 kilometers wide in places.

The section where the Amur river cuts through the northern extremities of the Greater Khingan mountains, its valley is comparatively narrow and its bed abounds with shoals. Below that section it divides the pre Amur plateau of the Lesser Khingan from the Niukzhe mountains and the Zeisk-Amur plateau, which are located in the USSR. Low stepped spurs and terraced foothill plateaus, pitted with ravines, descend to the river in this area. This sector is distinguished by the "Korsakov Bend" -- a great curve 45 kilometers long, after which the Amur approaches the portion lying above by only 600 meters.

In crossing the Zeisk-Bureinsk plain, the Amur river valley becomes considerably wider and is occupied by a number of large terraces that form a strip of pre Amur plateaus on its right bank (Huma Amur, Sakhalyansk, Sunghe Amur and others). Below that the Amur flows along a steep sloped, through mountain valley, the so called "Funnel". It cuts through all of the Lesser Khingan, isolating the Bureinsk mountains that are located in the USSR. This portion of the river abounds with rapids.

Below the "Funnel", between the mouths of Sungari and Ussuri, the Amur flows very peacefully, forming many branches among the marshy lowland banks. The unusual Kazakevichev channel branches out at a point above the mouth of the Ussuri river, and opens into the upper course of the Ussuri river. The direction of the current in the channel varies depending on the difference in the water levels of the Amur and Ussuri rivers.

The Ussuri river (Utse, or Suitse in Chinese) -- is the righthand border tributary of the Amur, which is formed in the USSR at a point where the Taubikhe and the Ulakhe rivers merge (the length from here to the mouth is 588 kilometers), on the left it receives the Sungacha (drains Lake Khamka) and Meng He, flows along lowlands, large portions of which are flooded during the summer, and forms many branches and curves. Its average width is 700 meters. The rate of descent is barely noticeable, the current is calm; the river is navigable

throughout, but abounds in shoals.

The Liao river -- is the principal river of Southern Manchuria, it is 1,500 kilometers long. Its sources are the Laohuhe on the right and Shara-Muren on the left, which are located in the mountains. It is only at its middle (latitudinal) course, where its main sources merge, that the river becomes known as the Sulehe (Western Liao); Liao proper is formed after the merger of Sulehe with Tunglehe (Eastern Liao). The width of the river is most inconsistent; it varies from 200 meters up to 1-1.5 kilometers (after the rains). The river water is muddy due to the presence of yellow-brownish loess clay particles.

In its lower course the river veers more sharply towards the southwest and irrigates the South Manchurian plain, and becomes navigable at that point. The lower course of this river is barred by dams, and supplies a network of canals. High tides create a contrary current, which is felt 40 kilometers upriver, that washes the delta area and prevents the accumulation of alluvial deposits in the delta. The mouth of the river is periodically flooded with sea water, the broad lowland marshy plain is strongly alkalai and is covered with reed and rush. The river is frozen from December until March.

#### The Soils.

The soils of northeastern China have not been heretofore studied to any great degree. The formation of various types of soil (podsol, steppe, alkaline) were first differentiated not as a result of field analysis but with the aid of extrapolation in the application of the landscape analysis. This was accomplished in the work of Soviet pedologists (V.A. Bal'ts and B.B. Polynova, 1930).

Here the soils form during the rainy and warm summer; they are thoroughly soaked and heated, which leads to the development of a luxuriant vegetation, a rapid decay of the fallen vegetation and the formation of humus, as a result of which, despite the extensive washouts, dark scils are predominantly found in the moist regions of the country: brown and grey forest soils as well as meadow chernozemic soils with various degrees of podsol are found.

The extensive processes of chemical erosion lead to a highly clayey soil and basic rock strata. Under the conditions of the considerable soaking during the summers and the wide-spread distribution of poorly drained plains and plateaus, this is conducive to the extensive formation of marshes. Eternal congelation in the northern portion of the country also aids in the development of marshes. The clayey nature of the soils is,

however, combined with a large amount of scree, which is associated with the size of the mountainous regions and foothill levelled areas, that form the largest portion of the plain.

The abruptly alternating dry and moist periods raise the dynamics of soil solutions; the descending currents, by means of which the dissolved salts are absorbed into the soil, are periodically replaced by rising currents, that raises some of the salt to the surface once again. During the preceding (xerothermal) epoch, the second one of these two processes was much more pronounced and the soils were more saline. Demineralization of the soils, which occurred as a result of the more humid climate, also, in many cases, led to their solothization.

Swampy-podsol and meadow-boggy soils have developed in the north and the east on the lowland taiga-swamp plateaus, and soddy-podzolic soils comparatively well saturated with humus, have developed in the mountain coniferous forests. Their contour on the soil chart forms an amphitheater together with the mountain ranges that surround the Sungliao plain. The soddy-podzolic soils are replaced by brown forest podsolized soil and dark gray forest soils in the southwestern lower belt of the mixed and broad-leaved forests, and in the south by soils that form the transitory belt to the subtropical yellow-podsolic soils.

Gray forest soils, which are podsolised saline, alkalai and sclodized in spots, as well as peculiar chernozem-meadow soils, incorrectly referred to as "Amur chernozem soil", and meadow alkaline-saline soils (on the Pre Hankai plain) predominate in forest-steppe portions of the country in the foothills of wooded mountains.

Leached chernozem soils that resemble the Kuban' chernozem soils are well developed along the southwestern foothills of the Lesser Khingan. To the south they turn into dark gray soils, that are found in the Harbin region (probably degraded chernozem). Chestnut soils cover the central areas of the Sungliao plain; its southwestern regions are covered with brown-steppe soils and even with chernozem. It abounds with alkalai flats, especially the river shoals. Saline and alkalai soils are predominant in the steppe adjacent to the Chinese Railway, in the left bank of the Nonni river east of Tsitsihar and in the dry southwestern portion of the plain.

Very swampy alluvial soils, partly dried and considerably altered through cultivation, are found in the extreme southwest, by the Liao river.

The abundance of autumn and summer rains considerably softens the soil making travel by road very difficult, whereas the thorough freezing of the ground during the winter permits

travel on steppes and swamps where roads do not even exist.

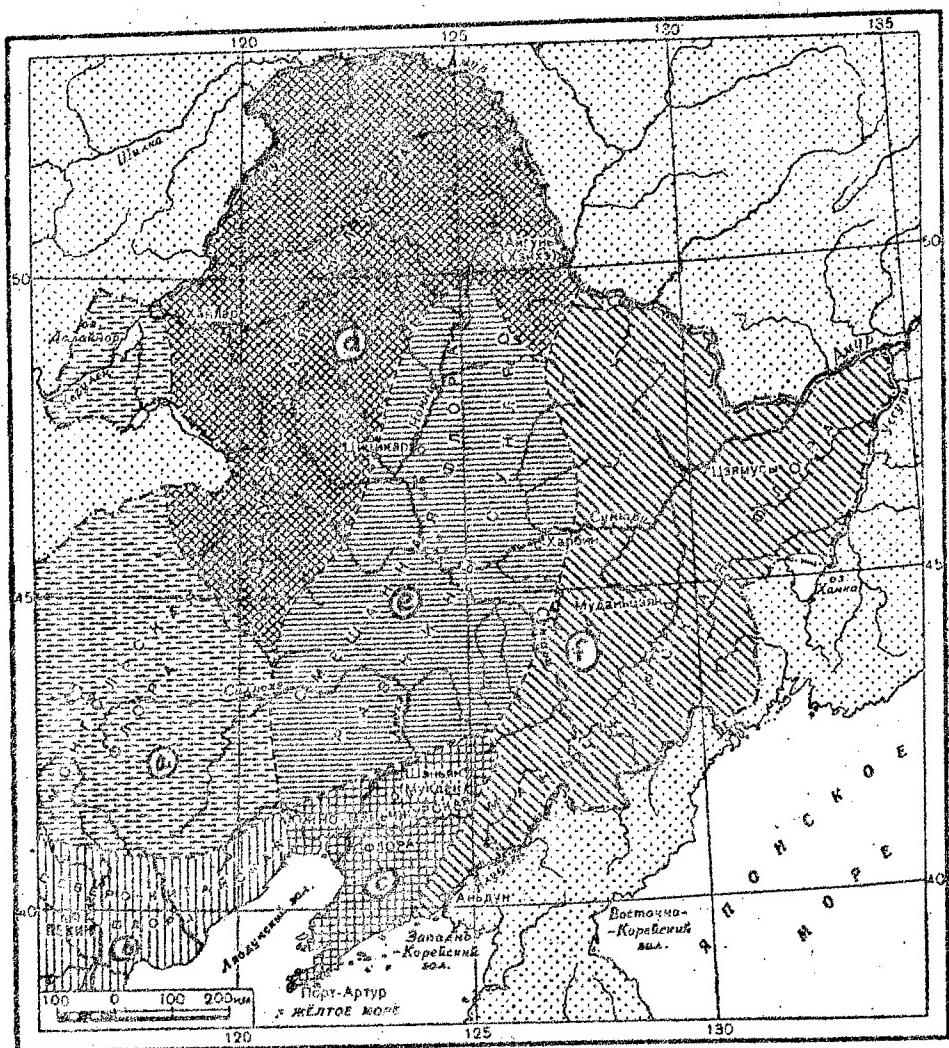
### Vegetation.

Vegetation of the northeastern portion of Asia beyond the border became known principally after explorations made by V.L. Komarov, which are classical ("The Manchurian Flora", 1901-1907). V.L. Komarov was the first to differentiate the "region of Manchurian flora" as a botanical-geographical unit, which encompasses the Manchurian-Korean mountains, part of the Lesser Khingan and the southern portion of the Soviet Far East between 40° and 50° Northern Latitude. O. Oga made the botanical-geographical division of the remainder of Manchuria (1931), who differentiated the following: 1) Region of the Daur flora west of the Greater Khingan; 2) The flora of the Manchurian plain; 3) The South Manchurian flora region (south of Mukden and on the Liaotung peninsula), and 4) The Mongolian flora region and that in the Liao mountains.

The cited purely flora division must be supplemented with a geobotanical division, as the borders of various plant formations do not always correspond with the indicated areas of the individual floras. The predominance of forest formations is characteristic for the Daur, South Manchurian and Manchurian flora regions (in Barga the forests are considerably denuded); steppe formations for the Mongolian region and the Sungliao plain. Along with these some peculiar transitory formations of the so called far eastern moist forest-steppe region cover the Pre Amur plateau, part of the Lesser Khingan, the northern portion of the Sungliao plain and the Pre Hankai lowlands. The lack of forests over portions of these territories is, according to V.L. Komarov, secondary, and is associated with the ancient agricultural activities of the local peoples.

The altitude zoning of vegetation is clearly expressed in the mountains.

The vegetation of the Manchurian flora region is striking in its splendor and variety, which, at first glance, appears to be inconsistent with the severe climatic conditions. Over 2,000 varieties of plants are known here, over one-half of which are endemic to Eastern Asia. A.N. Krishtofovich underlines the occasional incorrect classification of the present Manchurian forests as "subtropical". The Manchurian organic world (not only the flora but fauna as well) is the result not of a subtropical flora and fauna of the Tertiary period, but that of a moderate period, and it does not represent an impoverished heritage as the eastern part of Asia was characterized by a comparatively homogenous climatic condition during the Quaternary period. The devastating influence of Quaternary



The flora regions of northwestern China. (According to Komarov, Skvortsov and others).

Legend: a. Mongolian flora; b. North Altai flora;  
c. South Manchurian flora; d. Daur flora; e. Mixed flora  
of the Sungliao plain; f. Manchurian flora.

glaciation was not felt here, and the plants and animals of the Tertiary period survived the adverse conditions of the glacial epochs in the shelter of Northeast China. Hence an abundance of relicts and a somewhat archaic type of vegetation.

Therefore the great number and variety of organic species in the Manchurian region may be surprising only "in its contrast with the extremely impoverished animal world of Europe" (A.N. Krishtofovich, 1932).

An important peculiarity of the Manchurian flora is its exceptional wealth (over 250 varieties) of tree-bush vegetation. This is stipulated by the antiquity and the continuity of the dry land contact of this country with the subtropical and tropical regions of Asia, with the ancient dry land of Angaria and even with North America over the presently submerged Beringia. Many representatives of the tropical plant families came here from the south -- the magnolia araliaceous and other families, and from America and Angaria -- fir vegetation.

The cooler temperatures associated with periods of glaciation led not to the destruction and impoverishment of the flora but to its increased variety here, bringing about a progressive evolution of varieties with an increase in their adaptability to the cold temperatures. This permits the majority of the "southerners" among the Manchurian flora to easily survive the quite cold present day winter climatic conditions.

The drier and warm xerothermal period had a similar effect: along with the penetration of Mongolian and Daur flora into Eastern Manchuria, it was conducive to the evolution of a number of qualities adapting the Manchurian plants to the dry climate. It in particular brought about the evolution of a whole group of "Manchurian xerophytes" that are characteristic to the forest-steppes. These qualities aid the representatives of the Manchurian flora to survive the drought years, that are not infrequent under the present climatic conditions.

A natural consequence of the history of development is not only the complexity, but the contrast among the various types of plants and vegetation. The dry climate varieties are encountered along with the moisture loving plants, the southern varieties are fantastically interwoven with the northern varieties. Tropical appearing lianas, for instance, climb among the somber appearing northern spruce and fir trees.

The predominant form of vegetation in the Manchurian flora region is the mixed and coniferous (coniferous-broad leaved) forests. They are the most typical heritage of the Tertiary, so-called turgai broad-leaved forests. According to V.L. Komarov, at the end of the XIX century the number of deciduous varieties did not exceed 30%-40%. During the subsequent half century a decided decrease in the coniferous varieties occurred as a result of selective felling and forest fires in particular. The majority of the purely broad-leaved forests (oak, linden trees, oak-maple) is secondary that grew in place of the felled areas and areas devastated by fire.

Much of the endemic Manchurian flora are related to the European plants, but are represented by special Far Eastern varieties. Such varieties are the Korean cedar (*Pinus koraiensis*), the black or the Manchurian fir, the Mongolian oak tree, the Manchurian walnut (*Juglans manshurica*), the Amur and Manchurian linden, the Manchurian ash, etc. They are joined by the peculiar Far Eastern cork tree or velvet tree (*Phellodendron amurense*), many wild fruit trees (pears, apples, Manchurian apricot, etc.), the rapidly growing underbrush that consists of different varieties of honeysuckle, *lespedeza*, Amur lilac, rhododendron, Manchu filbert, aralia, etc.

The powerful lianas are quite remarkable. The climbing trunks of the "currant" (*Actinidia arguta* and *A. kolomikta*) attain a diameter of 20 centimeters, lending the forests an aura of tropical jungles. The Amur grape vines and magnolia vines (*Shizandra chinensis*) form dense thickets. Meadows of hemlock, as well as colorful meadows covered with different varieties of grass with magnificent iris, lilac and yellow day lilies can be found.

A Cedar-poplar and cedar-fir taiga with jeddo spruce and the Amur or Khingan fir are widespread in the upper mountain zone. These mountain coniferous forests are the descendants of cold-moderate dark coniferous forests of the American type, which grew north of the Tertiary Tuygay flora, that penetrated far to the south during the glacial epoch, and are now preserved under more severe climatic conditions of the upper mountain belts.

Forests composed of the stone birch (*Betula Ermanii*) are widespread at the upper limits of the forest area, above which are thickets formed by the spreading cedar (*Pinus pumila*).

In the South-Manchurian botanical-geographic region an abundance of oak trees is characteristic as well as chir pine, the presence of celsia, zelkova, Japanese alder, mulberry tree and a number of other more southern varieties of broad-leaved forms. The forests in this region are, however, destroyed to a great degree and the features of its southern landscapes is determined more by the abundance of artificially developed southern varieties, brought from middle China and Japan.

The dahurian flora is a transitory form between the Siberian and Manchurian floras. It consists of over 1,200 varieties, out of which 2/3 are Siberian and 1/3 local dahurian, Mongolian and Manchurian forms. The dahurian larch dominates the local landscape. The Mongolian oak, the Siberian filbert, the alder tree, the Chinese paper and river birch, the poplar, elm, Siberian apricot, Siberian hawthorn and others are also found here.

The dahurian larch taiga covers the northern half of the Greater Khingan with a dense and almost continuous cover,

except for the foothill areas and the southern slopes, on which the larch trees become shorter, scattered and yield to deciduous trees, and in the south to forest-steppe areas. The taiga underbrush is dense and variegated, especially on the southern slopes. They are dominated by the Amur rhododendron, different varieties of currant, honeysuckle, mountain ash, as well as small berry bushes. The mountain range ridges and individual summits (bare summits) are covered with thickets of spreading cedar. The southern (steppe) portion of the Greater Khingan, part of the Liao mountains and the southwestern plains only apply to the region of Mongolian flora in Northeastern China. Separate birch groves and low aspen and oak wood thickets intermixed with elm trees is all that remains of the Khingan forests.

A steppe type of vegetation predominates here, abounding in Mongolian xerophytes. The vegetation gradually acquires a northern Chinese appearance in the Liao mountains.

Vegetation of the Sungliao plain includes dahur, Mongolian and north Chinese varieties of herbaceous plants. The steppes are for the most part plowed up, with the exception of some of the drier (western) and saline sections which are used for grazing cattle.

The monsoon type of precipitation in the Northeastern portion of China creates favorable conditions for the cultivation of principally millet crops (kaoliang, green bristle grass or gutsza) as well as bean plants (soya beans), with rapidly developing root systems (which is important for adjustment to the dry spring seasons) that form an abundant leaf structure with a large surface evaporation area. Such a regime is not altogether favorable for grain crops that ripen by August. Corn, sesame, wet and dry rice, vegetable, watermelon and musk melon crops are widespread; cotton and yams are cultivated in the south. An important trade and cultural product is ginseng, which is a medicinal herb. There are many medicinal, volatile oil and other similar useful plants.

#### The Animal World.

An abundance of different varieties, a highly endemic and a clearly relict characteristic of the fauna, as well as exceptionally sharp contrasts in the combinations between the Siberian and the southern, Indo-Malayan elements are a feature of the Manchurian zoogeographical province. The brown bear, sable and the fritillary are encountered along with the tiger, the Himalayan marten and the blue magpie.

N.A. Baikov distinguishes three fauna regions in Northeastern China: the northern region, the southeastern region

and the western region.

The animal world of the southeastern region is the most complex and heterogeneous; it is comparable to that of south Ussuri where the Manchurian fauna is best represented. It includes the Korean and the Amur or the long haired sub-species of tiger, the east Siberian leopard or the badger, the Far Eastern forest tomcat, the Ussuri sub-species or the brown and the black bear, raccoon like dogs, the red wolf, the sable, marten, the Siberian ferret, the otter, the steppe polecat, the punctate deer, roe deer, the mountain antelope, the musk deer, the water deer, the wild boar, numerous bats, the Ussuri squirrel, the Manchurian rabbit, an innumerable number of mouselike rodents -- field mice, harvest mice, etc.

Outstanding among the birds are the pheasants, the roller (including the eastern broad bill), the halcyon, the cookoo, the flycatcher, the martin, the bunting, the black mallard, the Mandarin duck, the blue magpie, the thrush, the hawfinch, the flycatcher shrike, the broad billed crow, the Manchurian nightingale, the Chinese oriole, the Chinese and Japanese red legged ibis, the large white heron, the Chinese white stork and the fishing owl.

Outstanding among the reptiles are the tiger grass snake and several varieties of esculapian snakes; among them the esculapian snake Sherenka, or the Amur, which is sometimes incorrectly called boa constrictor, grows to a length of two meters and is occasionally domesticated as a household pet; it is a rat and mice eradicator.

The soft-skinned edible red-bellied terrapin, that is found in the waters of the Amur basin and in Lake Khanka, is quite original. Among the amphibians it is important to note the lungless Ussuri ambystoma, the zherlyanka, the Far Eastern toad and the Asiatic green frog which are endemic species.

Taking into consideration the peculiar variety of fish, L.S. Berg (1909) differentiates a special Manchurian (transitory Amur) ichthyological region, including the Amur basin as well as the Suifung and the Tumen rivers. It is remarkable in its combination of the Siberian, Aral-Caspian and southern varieties. The following are the Siberian varieties commonly found there: grayling, the taimen, the lamprey and many others; however, there are no sterlet, the Siberian sturgeon, nel'ma, perch, ruff and roach. The circumpolar varieties include the transient fish of the salmon family: calico, hump-backed salmon, the syma, which live in the sea but go to spawn at the upper courses of rivers which they once left themselves after hatching. Some of the Aral-Caspian forms absent from Siberia are the Russian sweet-sultan and the carp. More Chinese varieties of carp and silurus varieties of fish are found progressively farther south, including the Amur silurus,

the prickly silurus or the kasatka, as well as the tolstolobik and the zheltoshchek. The Chinese perch or the aukh, sometimes incorrectly called the ruff, and the crusian carp -- the initial species of the aquarium goldfish. The tropical snake-head (zmeegolov) is original. The Amur sturgeon grows to a large size here (almost three meters in length and weighs 160 kilograms), the kaluga, which here replaces the beluga, is especially large (up to four meters in length and over 800 kilograms in weight).

The insect world is particularly large; it is striking on the one hand in its beauty and on the other by the abundance of harmful insects.

In the summer mountain forests and the plains abound with the so-called "gnus" -- swarms of midges (simulid), mosquitoes, gadflies, warble flies and other blood sucking two winged insects whose bites are painful for both humans and horses. Certain mosquitoes are carriers of Japanese encephalitis, which is 70% fatal and causes paralysis and other serious nervous diseases in up to 20% of the cases. The tick, Ixodes persulcatus, carries the Far Eastern encephalitis. There is an innumerable number of Manchurian forest pests -- Far Eastern bark beetles.

The Manchurian butterflies are magnificent in their coloring and size; they include the swallow tail butterfly, the satyr, the peacock butterfly, the sphinx, the blue butterfly, and the silver-washed fritillary. At night the billions of fire-flies create a fantastic "illumination". A peculiarity of the east Asiatic fauna is the large long-horned beetle Callipogon and numerous other brightly colored beetles and carabides.

In the north (in the Chinese pre Amur region and the Greater Khingan) the fauna has Trans-Baikal-Amur characteristics with a great number of taiga and steppe varieties (elk, the roe deer, the wild boar, the musk deer, the brown bear, the wolf, the glutton, the fox, the lynx, the squirrel, the chipmunk, the hedgehog, the marmot, the black grouse, the willow grouse and the common partridge). The lakes abound with water-fowl and long-legged birds. There are many large beautiful butterflies. In the west the fauna is of the steppe type, closely similar to that found in Mongolia. The following are encountered here: the Mongolian gazelle, the wolf, the fox as well as certain rodents: the Trans-Baikal marmot, the marmot, the jerboa. Some of the birds inhabiting this area are the bustard, the bastard, the sand grouse, the Mongolian lark, the falcon, and the black griffon. Many of the insects are of the locust variety.

The fur resources of the northeastern portion of Asia beyond the border are most extensive. Hunting is the principal occupation of the population in the forest regions of the

country.

Large horned cattle, horses, sheep and pigs are the most important household animals. A great number of chickens, geese and ducks are bred. The silk worm is cultivated in the south.

#### The Physical-Geographic Division.

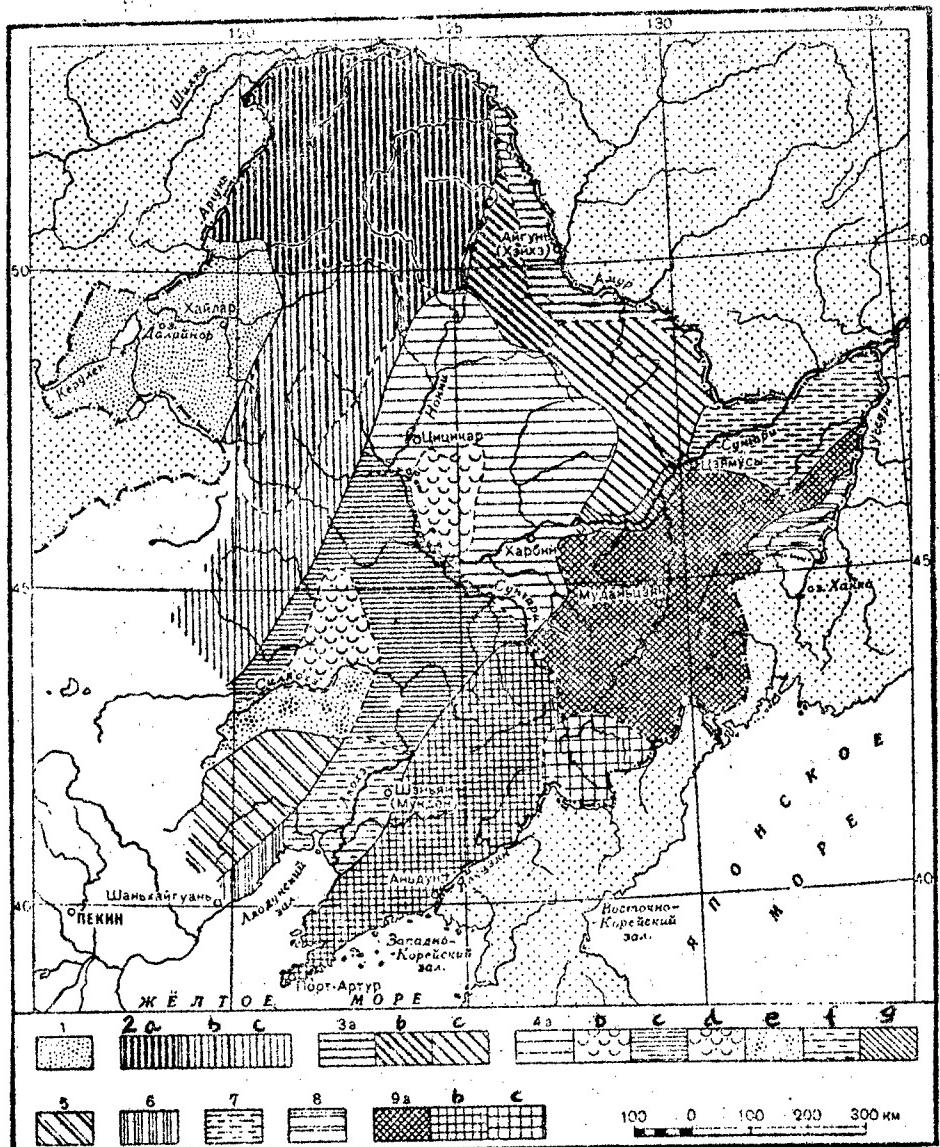
The physical-geographic division of Asia beyond the border is facilitated by the clearly defined division of the country into large geomorphological units, which are at the same time forming landscape categories. First of all the plains are clearly differentiated here, that differ from the surrounding mountains in their complex of features. While the western, northern and eastern mountains differ among themselves in both their tectonic-geomorphological features and in the prevalent climatic conditions and the organic world found in those regions (the cold north and the transition to the subtropical southern conditions; the transition from the maritime monsoon type of climate of the coastal areas to the sharply continental varieties of this climate in the interior of the mainland; transitions from the mountain-steppe and forest-steppe landscapes of the southwest to the mountain-taiga landscapes in the north and to the mountain broad-leaved forest landscapes of the southeast).

The combinations of the above varieties permits the individual characterization and differentiation of the following physical-geographical regions: the Liao mountains, the Greater Khingan, the Lesser Khingan, the plains of Northeastern China (Manchurian or Sungliao, Pre Hankai and the Amur-Sungari), Manchurian-Korean mountains and the Korean peninsula.

#### THE LANDSCAPE PROVINCES OF THE NORTHEASTERN PART OF ASIA BEYOND THE BORDER

##### The Liao Mountains (Zhehe).

The Liao (Liachsi), i.e. located west of the Liao river, are complex and sharply dissected mountains of average height, that cover an area of approximately 350 kilometers across. They form an intermediary link between the Greater Khingan mountains and Northern China, separate the South Manchurian plain from the North Chinese plain, they descend in steep southeastern slopes to the Yellow Sea coast. The only convenient passage is the coastal cornice, the narrow portion of which is called Shanhaikwan, i.e. "the mountain-sea gates", and the



The physical-geographic provinces of the Northeastern portion of China. (Compiled by Yu. K. Yefremov.)

1. Barga; 2. Greater Khingan; a. Northern; b. Middle; c. Southern;
3. Lesser Khingan: a. Pre Amur plateau; b. the Sakhalyanskiy Khingan; c. Intericr and Sungari Khingan; d. the Sungliao plain: a. the Northeastern plain portion; b. the Central saline region; c. the Southwestern region of dry steppes; d. the dune region; e. the South Manchurian lowlands; f. the Sungari corridor; 5. the Liao mountains; 6. Shanghaikwan corridor; 7. Amur-Sungari lowland; 8. Pre Hankai lowland; 9. East Manchurian mountains: a. Mutanchiang mountains; b. Liaotung mountains; c. the Changpai Shan plateau.

entire cornice is called the Shanhakwan passage or corridor. Another longitudinal passage through the Liao mountains is located in the Kubeikou pass region.

Tectonically the mountains of Liao are foreign to the systems found in Northeastern China and represent the northeastern end of the Luliang folds. The southern extension of the Greater Khingan adjoins the Liao mountains on the northwest, which are usually designated on maps as the Yin Shan mountains or ranges.

The Liao mountains are formed by the Yang Shan folded structures, that were created as a result of several phases of Mesozoic folding during the Lower Jurassic and Cretaceous period.

Archean gneiss and granite are found in the depths of the folds, which are covered by limestone and quartz of the Upper Proterozoic deposits, Cambrian-Silurian epoch, and by the Carboniferous Upper Paleozoic Liao deposits. They are in turn covered by sandstone and conglomerates of the Triassic period. All these rocks, including those of the Triassic period, were crushed during the Lower Jurassic period under the movements occurring during the first phase of the Yang Shan folding. The Mesozoic deposits, which was an era of most movement in Eastern Asia, is especially abundant in incongruities in the positions of the strata with frequently alternating facies such as thick carboniferous layers (Middle and Upper Jurassic), acidic and basic intrusions, fractures, faults and products of volcanism (Lower Cretaceous). Extensive Cretaceous chende conglomerates were deposited which were formed out of the old destroyed Yang Shan structures before the second phase of the Yang Shan folding. The associated denuded surface was considerably deformed during that phase (Middle Cretaceous period).

A level surface evolved here during the period ending with the middle of the Tertiary epoch. Limited movements and intrusions continued during that period. The area was draining to the southeast.

Vertical movements during the Oligocene and the Miocene periods were especially strong along their axis in the coastal areas, and shattered the levelled area, raised and differentiated the relief, formed various tilted areas (the maritime region and the Liao basin), rejuvenated erosion, brought about extensive basaltic effusions in the border region of the East Mongolian plateau fault; lava covered the rift valleys and formed a basaltic plateau.

Recent history of the mountains is associated with the inclusion of a number of western depressions into southern river systems, along with red Pliocene clay deposits, with Pleistocene accumulation and subsequent re-deposit of loess,

as well as with the continuation of vertical movements, which crushed and tilted the Miocene basaltic covers, and with the continued basaltic effusions during the Quaternary period.

The mountains formed as a result of these processes are predominantly 1,100-1,600 meters tall; the tallest mountain is Ulungshan, 2,050 meters.

In the LachaHe and the TalingHe valley regions there are six denuded foothill ledges; the highest one is located at an altitude of 460-490 and in places at 540 meters, and the lower ledges are situated at 60-120 and 30-40 meters.

Craggy sharply outlined ridges are a characteristic feature of the Liao mountains, as well as steep bare and scree covered slopes, and a complex chain of precipitous through valleys. The western, tallest part of the mountains is the most inaccessible; it is divided into two parts by the open valley of the LuangHe river. Small groves of larch trees, pines and spruce are encountered only by the tallest summits. The willow, elm, oak, cypress, filbert and poplar are some of the deciduous trees found here.

Lower altitudes (500-1,000 meters) are a characteristic feature of the eastern portion of the Liao mountains, as well as their easy accessibility and clear-cut lattice like divisions (there are as many as thirteen parallel rows in this region). Longitudinal valleys (LachaHe, TalingHe, and others) are broad, populated and cultivated (beans, kaoliang, green bristle grass), are abundant with orchards and serve as a convenient foundation for longitudinal means of communication, including two railroads.

Mesozoic sandstone, conglomerates and clays in the southeastern portion of the mountains are arranged in fantastic shapes resembling the badland areas. The coastal areas are also quite well dissected; they are composed of porphyrites and quartz and have completely lost all traces of their initial level surfaces. Some levelled surfaces are better preserved farther towards the southwest.

The northwestern frontal chains of the Liao mountains, that are usually designated as the Yin Shan mountains on the maps, are the southern extensions of the Greater Khingan, even though tectonically, and according to their basic terrain features, they are much closer to the Liao system and to the Luliang mountains that are situated farther south. These are a non-symmetrically raised southeastern fringe of the Chahar plateau with steep, short slopes on the northwest and with long, high and well-etched slopes in the southeast. The predominant altitudes are 1,300-1,600 meters; the highest point is 2,100 meters.

In contrast with the Greater Khingan, that has a continuous main watershed, these mountains are split by open

valleys of the upper course of the Luang He and Shantu He and are separated from the Greater Khingan by a depressed area and by the through valley of the Sharamuren river, and from the Luliang mountains by the Pai He river valley. All these serve as a convenient passage from Liao to Chahar.

East of the Shantu He river is the Weichang plateau, constructed out of Miocene basaltic effusions along the faulted fringes of the Chahar plateau. The movements that followed during the Quaternary period crushed and tilted these basaltic covers.

The mountain slopes are steep, rocky, bare and covered by steppes and scrub thickets (hazelnut, oak wood, juniper). In the north, at higher altitudes, groves of dahurian poplar, willow, pine, linden and fir are encountered. The old Wei-chuang park (formerly the Imperial Park) has been preserved. Artificially planted groups of elms and poplars stretch along the rivers. The settlements contain many orchards.

#### MOUNTAINS OF THE GREATER KHINGAN (TA HSINGAN SHAN)

The Greater Khingan is a long, meridionally stretched system of mountains of average height, that divide the Manchurian plains from the Mongolian plateaus and Eastern Asia from Central Asia. These mountains are not, however, a formation that divides the landscapes, as many elements of the Central Asian landscapes (non-draining alkalai regions, bitter-salty lakes, Mongolian xerophytes) are encountered east of the Greater Khingan in substantial volume. The landscapes of the Greater Khingan itself are of the mountain-steppe variety in the south, mountain-forest-steppe in the center, and mountain-taiga type in the north, and differ considerably from those of the neighboring plateaus and plains in their geological complexity, irregularity of terrain features and a comparatively greater amount of moisture.

The length of the entire mountain strip, if the Sharamuren river is considered as its southern boundary, is 1,200 kilometers long; its width between the foothills of the fringe spurs in the south is 120-150 kilometers, and 300-400 kilometers in the north.

The Greater Khingan is a sparsely populated and poorly surveyed region. The central portion of the mountains, which is traversed by railroads, is the one that has been principally explored.

The predominant absolute altitudes of the Greater Khingan are 800-1,200 meters, individual summits are as tall as 1,500-1,750 meters, and elevations in the order of 2,000

meters are found in the southernmost area which has not yet been properly mapped.

A sharply asymmetrical, transverse profile, associated with the difference in the foothill elevations is characteristic for the Greater Khingan, with the exception of its northern part. In the west the foothill plateaus are situated at altitudes of not below 700-1,200 meters; in the east the altitudes of the foothills are only 150-200 meters. The relative altitudes of the western slopes are considerably less than those of the eastern slopes. Even though the western slopes are less steep, they occupy a much smaller area than the steep and extensively etched eastern slopes.

The western spurs, that are dismembered because of a drier climate and a higher rate of erosion, represent hills and low mountains whose elevation is not very noticeable from the west. The eastern slopes, with the same absolute altitudes, are dissected into typical ranges of average height, which for the most part extend at a sharp angle towards the main watershed (towards the southeast), and sometimes change into frontal longitudinal chains. The slopes of these ranges are not steep, with softly undulating ridges.

Therefore, the dissected spurs of the eastern incline of the Greater Khingan form a mountain country in a true sense of the word. Its many ranges bear individual names, the chain of mountain ranges farther to the west, which contain the main watershed, are called the Khingan (Ta Hsingan Shan) mountains by the inhabitants. Inasmuch as the name of Greater Khingan has become a general term in geography for the entire mountain country, it is more convenient to refer to its watershed range as the Main Khingan range.

This range is clearly differentiated only in the northern half of the mountains. South of the Chinese-Changchun railroad it splits into a number of mountain ridges; the principal watershed passes from ridge to ridge and in places it even descends to the undulating plateaus.

Richthofen considered Greater Khingan as the upper step of the great east Asiatic fault ladder. Data provided by E.E. Anert permits it to be called a fault-folded mountain country, which forms an irregularly raised region of hertsian and Yang Shan structures of the neighboring Mongolian plateau.

V.M. Sinitsyn, in his attached sketch of Asian tectonics, classifies Greater Khingan as the intraplatform mountain structure of the Chinese platform.

A cross-section profile, along the Chinese Railway, drawn by Anert, indicates complex tectonic relationships among a number of strips including those consisting of quartz porphyry and tuff, as well as granite, diorite, basalt, metamorphic shale, and Permian limestone, porphyrites, various Paleozoic

conglomerates, sandstone, clay and siliceous shales, hornstone and archaen gneiss of the Paleozoic period. The granite intrusions are younger than many of the sedimentary rocks. The thick Baikal continental Mesozoic layer (there are sections of indisputably Jurassic carboniferous deposits) is found on structures created by Upper Paleozoic folding. There are also outcrops of recently effused andesites and liparites along both foothill areas of the mountain country, in addition to young volcanic relief forms.

The mountain relief of Greater Khingan was patterned out of the Mesozoic or Tertiary levelled surfaces, which experienced arched uplifting. Two layers of levelled surfaces were described by Wan and Tan in the Nonni basin, one of which is located at a height of 320 meters and the second one 100 meters lower. They cut through all types of rock from the Cretaceous period to the Archean. The present day valley at the upper course of the Nonni river cuts into the lower surface up to a depth of 70 meters.

The Greater Khingan, in contrast with the Liao and the Manchurian-Korean mountains, is devoid of any intermountain depressions, but abounds in wide, ramified and swampy valleys. The upper reaches of these valleys are especially wide and shallow, as they have not yet been fully affected by the latest processes of erosion.

In the Greater Khingan the steppe-like south, the steppe-forest center portion and the taiga northern part of the mountain country are sharply differentiated in the forms of vegetation and landscapes.

The southern part of Greater Khingan is the highest and totally without forests. This is a wide mountain-steppe country, that extends along the meridian for 400 kilometers and is over 200 kilometers wide.

The tallest of the known summits (a nameless highest point in the Greater Khingan) is 1,958 meters.

The ridges are even and are of the same height over long stretches, which is reminiscent of the existence of unified sources of surface levelling. In contrast with the more rounded and gentle forms of the more humid and wooded north, the south abounds with coarse, sharp and craggy relief forms, that are peculiar to steep and barren slopes under dry steppe conditions.

The mountains contain numerous paths and passes, that lie at altitudes of 650-1,200 meters.

The central region of the Greater Khingan (Central Khingan), which is 200-350 kilometers across, differs in that it is much more accessible and lies along principal passages out of the Soviet Trans-Baikal, Eastern Mongolia and Barga into the central part of Tung-tai.

In the extreme south it is crossed by a highway and (through a tunnel) by a railway from Ulan-Hoto (Ulan-hemiao) Halun-Terhshan(Wentsuan), which are laid across the so-called Solun passage and the Nuhut'ing-Tabang pass (1,380 meters). A road passes farther to the north through the area of an old cow path called Hailar-Tsitsikar and of the Chinese-Changchun railroad. The railroad surmounts the pass with the aid of an unusual loop and a three kilometer long tunnel. Still farther north is the badly neglected so-called Kropotkinskiy road, that leads from Trekhrech'ye to Nunkiang across the Hsingan pass (1,030 meters).

The principal Khingan range here extends from the southwest to the northeast; it has an axial position only in the north; in the south it moves towards the western edge of the mountains. Its angular summits are split by plateaus and swampy dales.

The predominant altitudes of the Main range of 300 meters increase to 1,749 meters in the south (the Nuhuting mountain). The western spurs are gently sloping, and do not exceed 60-150 kilometers in length and are 200-300 meters in relative altitude. The southeastern spurs are dissected and are more complex and deeper; they extend over an area of 200-350 kilometers, and in spots are taller than the Main range. The largest one of these is the Yakeshan range, that is separated from the Main range by the river Cholo valley.

The slopes of the Greater Khingan were formerly covered with mixed forests, in the east down to the very bottom of the mountains and in the west only to the foothills, which previously had no forest cover at all. The southern slopes both in the east and the west are predominantly steppe. The forest has been cleared along the railroad tracks, and in timber production areas the forest has been thinned down considerably. The coniferous trees were the ones that were predominantly felled.

The northern portion of the Greater Khingan (the Northern or the Argun-Amur Khingan) is distinguished by its especially severe climate, and is covered with forests (Dahur taiga), which consists mainly of the Dahur larch, and of birch grove and oak wood on the southern slopes. Permanently frozen ground is found throughout; its depth varies from 35 meters north of  $50^{\circ}$  Northern Latitude and up to 100 meters in spots. South of  $50^{\circ}$  the frozen ground contains windows -- talik, and the thickness of the permanently frozen layer does not exceed 15-35 meters. Permanently frozen ground causes a number of typical phenomena such as soil swelling, the formation of thin sheets of ice on the surface, and thermocarsts. The solifluction and swamp formation processes are intensive.

The northern portion of the Greater Khingan in particular

is poorly studied. This is a wild area that is almost unpopulated over great regions and contains no roads; it covers an area of 450 kilometers across. Until 1947 even its relief was represented with fantastic distortions.

In contrast with other parts of the Greater Khingan, Northern Khingan has a comparatively symmetrical structure: the Main Khingan range passes through here almost along the axis of the mountain country, containing summits that are predominantly from 1,000-1,200 meters tall. One of the spurs of the Okoldoi mountain (Okoridoishan) attains an altitude of 1,530 meters.

An important structural line in Northern Khingan is apparently the latitudinal line that crosses the Main range 60-70 kilometers south of the Okoldoi mountain. Two spurs of the Greater Khingan are located here, one opposite the other, and form what appears to be a single diagonal range. The morphological unity of the spurs is reflected in their names: the eastern spur bears the name of Ilkhuri-Alin, the western spur bears the same name in its Chinese translation -- Ilihuli chan.

Ilkhuri-Alin forms a broad arch between the Greater and the Lesser Khingan and divides the basins at the upper courses of the Amur and the Nonni. Its altitudes diminish from west to south from 900-1,200 meters to 400-600 meters. Due to a lack of data on the northern portion of Manchuria, the orographical significance of the Ilkhuri-Alin was exaggerated for a long period of time. Its significance as a watershed was transferred to its orography and Ilkhuri-Alin was referred to almost in terms of an individual mountain country equal in rank to the Greater and the Lesser Khingan. The latest maps force the rejection of such concepts. Ilkhuri-Alin is a regular spur of the Khingan. Many secondary spurs that extend from the Ilkhuri-Alin towards the northeast and the southeast, exceed it in altitude and further stress the insignificance of the watershed range.

The peculiarities of the geological structure are quite different. E.E. Anert (1928) considers the Ilkhuri-Alin a fault-folding range, structurally older than both the Khingans. The central portion of the range is composed of archean gneiss and granites, the peripheral parts -- of metamorphic Proterozoic matter, lower Paleozoic and young effusions. The southern fault is spotted with groups of southern volcanoes, that form an extension of the volcanic outcrops of the Sakhaliantskiy Khingan. The Ilkhuri-Alin is crossed by infrequent paths and a single road, that leads from the south to the Huma-Amur plateau.

A peculiar region in the west of the Northern Khingan is formed by the so-called Trekhrech'ye containing the valleys

of the Kenghe, Haul and Terbul rivers, that are divided by the spurs of the Ilikhuli Shan. This is the most densely populated area of Northern Khingan, which has for a long time been occupied by Russian emigrants from the Trans-Baikal. The center of this region is the Dragotsenka.

#### THE LESSER KHINGAN MOUNTAINS (HSIAO HSINGOAN SHAN).

The Lesser Khingan is an extensive little known mountain country, that covers a strip almost 600 kilometers in length and 120 kilometers wide that broadens to 350 kilometers in the south. Certain writers tend to include the entire northwestern half of this region (Nonni-Amur range and the Sakhalyanskiy Khingan) along with the Greater Khingan; this is, however, difficult to accept as the depression at the upper course of the Nonni river and the direction of the descent of the Ilkhuri-Alin range almost to the level of the surrounding plateaus serve as sufficient orographical peculiarities to isolate these areas from the Greater Khingan.

Mountains located between the Bureya, Amgun and Amur rivers in the USSR that are separated by the through ("Funnel") Amur valley from the Chinese Lesser Khingan that is described here, are also known as the Lesser Khingan. In order to avoid any confusion it is now common to refer to the Soviet Lesser Khingan as the Bureinskiy mountains (Bureinskiy range) and to apply the name of Khingan, that is well entrenched with the population, only to separate sections of these mountains (Birobidzhan Khingan, Bureinskiy Khingan). Both the Soviet section and the one beyond the border are both sometimes referred to as a single unit, known as the Khingan-Bureinskiy mountains.

The Lesser Khingan are homogenous, partially wooded mountains and plateaus. The structure of a large part of this territory still remains unknown. Even the orography of a portion of the mountains is known only in the most general terms and the relief of some of the territories is still only recorded on maps in hypothetical terms.

The predominating plateau altitudes are 300-400 meters, and of the mountains 400-600 meters, individual summits rise to 700-1,150 meters. The mountains are dissected by a complex system of valleys of the Amur, Sungari and Nonni river tributaries. The valleys are 100-300 meters deep.

The ridges are undulating with gently sloping cupola shaped summits. Pointed craggy bare summits are encountered only in some of the higher areas. Deposits of very large rock boulders are common on the ridges, which is a result of

specific present conditions of wind erosion in conjunction with moist summers and severe winters, or perhaps a relict of a more severe climate that existed during the epoch of glaciation, that did not reach this area. Numerous sections containing slightly dissected plateaus are found along with the ranges. Most of the valleys, that are narrow and have steep slopes in their middle part, contain wide and gently sloping upper reaches, which have not yet been fully affected by the most recent erosion.

The bottoms of the valleys and plateaus are very swampy and permanently frozen ground is widespread.

The Lesser Khingan, according to E.E. Anert (1928), are fault-folded mountains, that apparently basically consist of granite, gneiss and crystal shale. In addition, thick Upper Paleozoic, Jurassic and Tertiary layers were revealed in the through Amur valley.

The higher southeastern portion of the Lesser Khingan, that adjoins the Sungari corridor, the so-called Sungari Khingan, and a large portion of the Interior Khingan, which contains the main Sungari and Amur watershed, relates to the Manchurian flora region and their landscape characteristics closely resemble the contiguous portions of the East Manchurian mountains. This is the least populated, wild and little known region of the Lesser Khingan.

Only the slopes that are adjacent to the Sungari river and the area along the entire length of the Suiliang railway which crosses all of the Sungari Khingan (Suihwa-Liangtsiankou), are populated and partially cleared of the forest, in addition to the Haolikang coal basin (Hegan). There are only isolated hunters and gold prospectors' paths crossing the Inner Khingan and its many northern spurs, that are divided by the Amur tributaries. Low mountains and swampy, terraced Pre-Amur plateaus that contain a road which follows along the length of the river, adjoin the Amur. A low hill Sungari Khingan virgate adjoins the Amur "Funnel", where the plateaus end it is somewhat more densely populated (gold fields). The through area of the Amur valley is 200 kilometers long. The Lesser Khingan becomes considerably lower in its northwestern portion, forming an area of low hill mountain ridges and rolling plateaus, which are called the Sakhaliantskiy Khingan. In contrast with the preceding regions this is a more accessible, populated and explored portion of Khingan. The most important Trans-Khingan highways cross this region: the Old Mergen road in the center from Nunkiang to Aigun, the Old Aigun or the Lungchen road in the east and in the northwest the Old Priiskovyy road also between Nunkiang and Aigun. The general altitude of the passes is approximately 400 meters.

The Sakhaliantskiy Khingan landscape is striking in the

thinned-out appearance and the short trees of its forests, the absence of coniferous varieties, an abundance of glades among the birch, aspen and oak groves; forests are encountered in isolated clumps among the extensive areas containing glades and steppes covered with different types of grass, the landscape therefore assumes the appearance of a forest-steppe and a steppe.

A broad, hilly plateau, that occupies the area between the Amur river and its right tributary, the Sungkhe river, which flows at quite a distance parallel to the Amur, adjoins the Amur valley. A strip 10-20 kilometers from the Amur is populated, cultivated and is provided with roads. Important centers of the Chinese Pre-Amur are situated on the Amur -- the city of Aigun (Sakhalyan or Heiho) which is located opposite Blagoveshchensk, Tsu Liun and other cities.

Original young volcanic regions are located by the foothills of this part of the Khingan, that mark large faults, which differentiated the Sakhalianskiy Khingan: Udalyanchi (Uyun-Holdongi), Kelonangshan, Erhkiang and Erhkeshan. Eruptions occurred in the Udalyanchi region as recent as the 1720's, as determined by a Russian sinologist, V.P. Vasil'ev, who deciphered the Chinese chronicles and thus discovered the existence of these volcanoes before they were discovered by geographers. P.A. Kropotkin (1865) was the first explorer to visit these volcanoes. The Russian geographer Visolukh visited these volcanoes in 1911 and described them in detail; they were subsequently studied by Soviet, Chinese and Japanese geologists.

All four of the volcanic regions represent gently sloping, undulating plateaus 300-400 meters high, which have massive lava covers, that form a socle for small (70-100 meters) volcanic cones with craters 30-130 meters deep. The Shinlung lava flow, which occurred in 1720-1722, is over 15 meters long, 1-3 kilometers wide and is sharply differentiated among the surrounding forest-steppe by its black and lifeless undulating-bubbly surface. It blocks a group of lakes at Udalyanchi, which have a grotesque vase shape. There are 14 volcanoes in the Udalyanchi group, six volcanoes in the Kelonang (Koronang, Korolhiang) Shan group, one of which exudes warm gasses at the present time.

The meridionally situated Nonni-Amur range, which connects the Lesser Khingan with Ilkhuri-Alin is located northwest of the Sakhalyanskiy Khingan. Low deciduous forests (oak and birch) are replaced with typical dahurian taiga towards the north. The only more populated region is the Huma-Amur plateau, which is located by its northeastern foothills along the Amur river.

## THE MANCHURIAN PLAINS

The Manchurian plains are concentrated in the central and northeastern portions of the country. They are found in the broad intermountain depressions, which are filled with ancient lake and alluvial deposits. The landscapes of these plains may be divided into two groups according to climatic differences between the central and northeastern regions:

- 1) The densely populated and cultivated steppe plains in the center and in the southwest (Central and South Manchurian plains, together forming the Sungliao plain);
- 2) Meadow-marshy and forest-steppe wild and sparsely populated plains of the northeast (Pre-Hankai and Amur-Sungari plains).

The plains of the South and Central Manchuria are separated by a barely noticeable hilly watershed less than 330 meters high. The construction of a canal between the Liao river and the Sungari canal is possible here. The predominant absolute altitudes are: 100-300 meters in the center, and below 100 meters in the southwest. The South Manchurian plain is basically cumulative, the Central Manchurian plain is eroded to a considerable degree. Both plains, especially the center plain, contain much sedimentary rock -- knolls formed by gneiss, granites, quartz and basalt. Some of the more outstanding volcanic groups are the Tsinsing Shan (Chihsingshan) by the Liao-Sungari watershed and strips of volcanoes next to the foothills of both of the Khingans.

### The South Manchurian Plain.

The South Manchurian plain forms a broad (120 kilometers) lowland strip between the Liao and Liaotung mountains, and joins Central Manchuria with the Yellow Sea coast. This is a typical alluvial plain, almost entirely created by the activity of its moulding artery, the Liao river. The valley consists of saline sediments from the recently receded sea in its coastal area only. The former harbor of Niuchuang is now located 40 kilometers inland.

The coast of the Liaotung peninsula consists of lowlands, flat, sandy and rectilinear. It is indented with only one shallow bay called Talien Hekow. Low tides and high tides are up to three meters high here. At low tide a broad silt covered coastal strip 2-4 kilometers wide is revealed, that widens to 15-20 kilometers in places. Areas 10-20 kilometers wide and tens of kilometers long are covered with thickets of reed, rush and salt works. The salt works are partitioned from the

sea by a series of dams, and further divided by secondary dams into rectilinear basins, which are flooded by turn during high tide. The only port convenient for navigation on this coast is the port of Yingkow at the mouth of the Liao river.

The plain itself consists of three longitudinal strips: the flattest lowland and marshy axial strip is formed by the flood lands and low terraces of the Liao river; tilted plains stretch along both of its banks; these plains consist of merged cones and talus at the foothills of Liao and Liaotung mountains. These tilted plains are covered by gently sloping hills, are better irrigated and drained, especially the eastern ones, which is why they are the principal agricultural belts and are the most densely populated. The line of the former South Manchurian railroad, which forms a part of the Chinese Railway, passes along the bottom of the Liaotung mountains. Large cities are located here: Mukden (Shenyang), the ancient capital of Manchuria, Liacyang and the large industrial center of Anshan. The main battles of the Russo-Japanese war of 1904-1905 took place in this region.

Cultivated fields, planted with beans, corn and kaoliang dominate the landscape, rice crops are encountered in the flood-land areas. A strongly lowland type of vegetation is commonly found on the rare uncultivated sectors, which consists of motley grass and grassy steppes. The soils are brownish-gray and light-chestnut, along the Liao they are alluvial and saline. Groves of trees (aspen, poplar, alder) are found only next to monasteries and some villages. There are also a few orchards. Pines are sometimes seen on the foothill knolls. Sections containing luxuriant high grass meadows alternate with thickets of reed, osier-bed, thallus plants with cordate groves of elm, wild apple, poplar, aspen, hawthorn, dog rosa and birdcherry in the Liao valley.

There are many saline depressions in the western portion of the valley as well as aeolian sand with shifting dunes. The sand hillocks are commonly covered with osier-bed thickets, while the hollows between the hillocks contain saline marshes.

#### The Central Manchurian Plain.

The Central Manchurian plain is the largest one in the northeastern part of China (over 500 kilometers across). It is surrounded with mountains on the west, north and east, and opens widely towards the southwest; to the northeast it opens through the narrow Sungari corridor. There are a series of young volcanic outcrops along the faults, where the lowering of this large depression occurred in at least two stages.

The folded foundation of the periphery submerges below the remnants of slightly crushed continental layers. The depression is filled with Tertiary (clay, marl, sand) and with Pleistocene thick cumulative layers. At the beginning of the Pleistocene period it was occupied by a large lake, in which sandy clay was deposited, and sand and gravel in its peripheral area.

After that slight undulating longitudinal uplifting movements occurred in the region of the Liao-Sungari watershed, which were associated with the Tsinlingshan basaltic effusions. The lake was apparently lowered and the initial cumulative Pleistocene surface was subjected to dismemberment through erosion. Therefore, in contrast with the purely cumulative nature of the South Manchurian plain, the Central Manchurian plain contains basically an erosion relief.

The peripheral region of the valley is hilly, and consists of gently tilted foothill areas covered with rock fragments and split by hollows. The central areas are flat and are occupied by extensive floodland areas of the middle courses of the Sungari and Nonni rivers.

The vegetation of this plain is of a mixed nature. The moisture loving representatives of the Manchurian flora are encountered only in its eastern portions and in the more moist river valleys. The basic elements of the flora are composed of the dry growing plants that came from North China, Mongolia and Dahur.

The Manchurian steppes are very abundant in different varieties of plants; their appearance in the spring presents an exceptionally colorful and complex picture. April -- is the time of bell-flowers, buttercups, cinquefoil, basket ivy, violets, and iris; light yellow fields of haemachromes appear during May; and wild asparagus, centaurea, alfalfa, blue larkspur and many others are seen in June. Forests, which are found mainly along the rivers, are badly destroyed. Isolated elms, poplars, osier-bed, hawthorn, alder and buckthorn are found.

Cultivated fields, which replaced the original steppes in this area, are seen in the landscapes of the more moist eastern portions of the plain. The best plots are located between the rivers, that were composed during the Pleistocene period, the valleys are usually marshy and saline.

Xerophytization of the vegetation is noted from east to west along with the advent of a drier climate. It is possible to observe the change of motley-grass steppes and chernozem soils, typical in the northeast, to grassy steppes and chestnut soils in the center, and dry sagebrush-grassy steppes with brown and gray soils in the west. The amount of cultivated land diminishes towards the west, while the area covered by grazing land increases sharply.

The dry conditions prevalent in the western half of the plain are reflected in the scattered hydrographic network. A whole series of areas have no surface water. Salt flats and in places, salt lakes, are frequently encountered on the bottom of the non-draining depressions. There are sections covered with aeolian sands (including shifting dunes). All this appears to be the northeastern avantgarde of the Central Asian landscapes.

Reforestation designed to protect the fields began in the western portion of the Sungliao plain, as well as intensified work in the construction of canals and the regulation of rivers.

The northern portion of the Sungliao plain which is irrigated by the Nonni river has a hilly, undulating relief that gradually shifts to the foothills of the Ilkhuri-Alin and Lesser Khingan. Isolated groups of trees are scattered here among the steppes, the chernozem is replaced with gray forest soils, and the landscape on the whole acquires the traits of a forest-steppe, which are fully expressed farther to the north -- in the Sakhalayanskiy Khingan.

The eastern part of the plain is densely populated. The plain is crossed by a number of important highways, including the Chinese Railway. Among the numerous cities the following are the most outstanding: Harbin, Changchun, Tsitsihar, Peihan, Ulan-Hoto and Nunkiang (Mergen).

#### The Pre-Hankai Plain.

The Pre-Hankai plain is divided into two parts by the Soviet-Chinese border, that passes through Lake Khanka, along the Ussuri and Sungacha river tributaries and through Lake Khanka itself. The western, Chinese, portion of the plain is irrigated by the lower course of the Huleng He river. The plain intrudes up along the Huleng He valley between two branches of the East Manchurian mountains, the Pogranichnyy and the Nadan-Hada-Alin ridges, in the form of a bay. Isolated knolls are seen along the flat Pre-Hankai lowland area along the northern shore of Lake Khanka, in addition to low hills 300-500 meters tall, that are apparently fragments of submerged South Manchurian structures or volcanic outcrops.

Lake Khanka, Hsinkaihu in Chinese, is situated at an altitude of only 46 meters; it is 96 kilometers long and 48-85 kilometers wide, and is very shallow (its depth fluctuates between 2 and 10 meters, at a distance of one kilometer from shore it usually is not deeper than 0.5 meters). Its western shore is elevated, the other portion of the shoreline is low, subject to flooding under the frequent sharp increases in the

water level. A series of ledges testify that the lake underwent several stages of dehydration. Lake Khanka is reknown for its abundance of birds. The left bank of the Ussuri river is distinguished by a flat relief, lack of trees, very swampy territory, and is covered with damp meadows over large areas; it is very sparsely populated and has almost no convenient roads. Only the better drained strips of land close to the Ussuri and Muleng He rivers are more highly populated. Dense groves of poplars and willows are encountered here. The foothill areas contain scattered oak groves, and the landscape acquires the characteristics of a forest-steppe.

#### The Amur-Sungari Lowlands.

The Amur-Sungari lowland area represents the largest section of the Middle-Amur plain belonging to China, a big portion of which is situated within the Soviet Union. This is a very scarcely explored region predominantly consisting of meadow-marshy landscapes, in the better draining areas, which become damp variations of the far eastern forest-steppe in the better draining areas. Strips of low hills that are the fragments of submerged folded foundation structures, and perhaps young volcanic outcrops, are seen among the thick alluvial layers that fill the broad tectonic depression. The Amur and Sungari rivers flood extensive areas of the plain.

#### THE MANCHURIAN-KOREAN MOUNTAINS

This broad mountain region of average height extends from the Kwantung peninsula (Kuantung) in the southwest up to the middle course of the Ussuri river in the northeast over a distance of 1,400 kilometers. Its principal features are the complexity of its geological structure and of its landscape, the presence of considerable mineral wealth, which is extensively exploited during the recent years; a sharp contrast between the great expanses formerly covered by forests in the southwest and in the foothills and depressions and by the broad massifs formed by cedar-broad leaved forests in its central part and in the northeastern portion of the mountain country. This area contains a concentration of Manchurian flora.

The Sungari, Yalu and Tumen rivers originate in deep canyons under the highest summit of the Manchurian-Korean mountains, the Paitou Shan (2,744 meters). The Yalu and Tumen rivers flow in opposite directions almost in a continuous line and together form a longitudinal furrow. It clearly divides

the system into two unequal parts: the smaller and higher portion -- the North-Korean mountains in the southeast, and the larger part, which is lower -- the East Manchurian mountains in the northwest. Both lines merge in the broad basalt plateau called Changpai Shan, which is a name that is frequently applied to the entire system.

The history of the formation of Manchurian-Korean mountains has much in common with that of the Korean peninsula. This is a granite-gneiss fragment of the Shantung-Korean shield, which is only in spots covered with a somewhat dislocated Upper Proterozoic deposit and layers of Paleozoic deposits, and which was crushed and underwent new intrusions during the Mesozoic period, and during the Tertiary and Quaternary period it experienced arched uplifting, faulting and great basaltic effusions. The largest of these formed the Changpai Shan plateau and several less significant plateaus. Young folded structures, formed in the East Asiatic geocyclinal region, are found only in the extreme east (Tumen mountains, part of the Mutanchiang mountains).

Along with the plateaus that are covered by basalts, there is a widespread number of plateaus that represent the surviving remnants of an ancient levelled surface. The most extensive levelled areas in the North Korean mountains form the Kema (Kayma) plateau. Platforms of upper even levelled surface are encountered in the East Manchurian ranges only in certain places, and they may be mentally recreated only on the framework of equally tall ridges.

The lower denuded ledge is widespread, which on the Liaotung peninsula has undergone only an insignificant up-lifting and forms an easily accessible hilly country with isolated sections containing low hills with steeper slopes.

The level areas are sharply contrasted with the relief of those portions of the plateau that have already been subjected to rejuvenation through erosion. Very large canyons, an innumerable number of valleys with steep slopes form a continuous, ramified network.

The East Manchurian mountains, beginning from the North Korean mountains, are distinguished by an abundance of broad intermountain depressions with a low hill relief that is suitable for habitation.

There are considerable climatic differences between the individual parts of the Manchurian mountains that are associated both with the difference in the latitudes, and the position of the slopes with relation to the sea and to the dry southern steppes. The climate by the northeastern end of the mountains is not much milder than that at Khabarovsk, and the climate prevalent in the southwest differs little from the climate of North China. The climate of the high upland areas of Kem and

Changpai Shan is especially severe, where a small independent anticyclone area is formed during the winter.

The upper (mountain) course of the Sungari river is located within the limits of the Manchurian-Korean mountains; its largest right tributary is the Mutankiang, as well as the "twin rivers" the Yalu and the Tumen (over 450 kilometers long) along with their numerous tributaries. All these rivers are full bodied and turbulent, and are open to navigation by small motorboats only at their lower courses (the Yalu river has a sea glider system of transportation); they have a great general significance. The main peculiarity of these rivers is their potential source of hydroenergy, and the fact that this potential is being exploited to a great degree. The numerous hydroelectric power stations that are constructed here serve as a powerful source of energy. The largest power stations are the: Tafengman on the Sungari river above Kirin, Tsingpohou on the Mutankiang river, Supung or the Hsiaofengman (640,000 kilowatt) on the Yalu river, several electric power stations that are supplied with water from reservoirs on the Yalu river tributaries (Khuntsiang, Hochhongan, Luchzongan, Chanchingen, Suorgan), Tumentsiang (on the Sodusu river), and so on. All these rivers are barred with dikes of up to one kilometer in length and up to 100 meters in height, above which large reservoirs of 100-550 kilometers in area have formed.

The Manchurian-Korean mountains form the principal center of formation and distribution for the Manchurian relict flora.

Deciduous forests are typical for the valleys and southern slopes, while coniferous forests are common to the northern slopes. The forests have been considerably depleted by the large roads, in the intermountain depressions, adjacent to populated areas and especially in the southwestern portion. The valuable coniferous varieties have been poorly preserved in the surviving forests.

Linden and oak wood trees are predominantly found in the zone below 700 meters -- they form dense and clean broad-leaved thickets with an unpassable underbrush and lianas. The cedars, that form the predominating mixed forests of Korean cedar along with a great number of broad-leaved varieties with a dense underbrush and lianas, grow up to an altitude of 900 meters. Fir wood is encountered as high up as 700 meters, and areas above 900-1,100 meters contain spruce-fir forests; both areas include some deciduous trees. The high plateaus (Changpai Shan Lesser Changpai Shan are covered with forests consisting of the dahurian larch with rare damp glades. The area above the forest line (1,200-1,400 meters) contains bare mountains with thickets of the spreading cedar and piles of

very big rock boulders eroded by the wind.

Strips of meadows, overgrown with tall grass -- meadow grass and spotted with the colors of red dahurian lilies are encountered here.

The border between Korea and China passes along the Yalu and Tumen rivers and, consequently, between the areas predominantly inhabited by the Chinese and the Koreans. Intermountain depressions contain the densely populated areas; their hilly-plain expanses are planted throughout, in the south with rice, towards the north with beans and kaoliang. The population in the new industrial areas of the South Manchurian, Tungpiangtao, Musan-Khverensk and the region of the North Korean ports and the city of Dairen has grown considerably. Large industrial centers originated here due to the availability of cheap hydroelectric energy and mineral wealth (Anshan, Fushun, Penchi, Chongjin, Musan, Kim Chak (Songjin)).

Despite the difficult terrain, the mountains are traversed by a number of railroads and auto roads. The important passes: a section of the Chinese Railway Harbin-Pogranichnaya ("Pingsui" railway), the Tsingtou railway (from Kirin to the North Korean portal region), the Ssuping-Tunghwa-Pyongyang railway, the Mukden-Antung railway, and a number of roads.

Among the longitudinal railroads the most important one is the South Manchurian branch of the Chinese Changchun railroad, that passes along the northwestern foothills of the Liao, Liaotung mountains, and a number of railways along the large longitudinal valleys (along the Yalu, Tumen, Muleng, Mutankiang and others).

### The East Manchurian Mountains

The East Manchurian mountains is a name applied to a large northwestern strip of the Manchurian-Korean mountains, that stretches along its entire length. This is a region of wooded ranges of average height and treeless intermountain depressions, which is fringed by also treeless low mountain areas. The valley of the upper course of the Sungari forms a border that divides two of its most different portions. The Southwestern half is frequently called the Liaotung mountains, the northwestern half, an area between the Sungari and the Ussuri, has no commonly accepted name, but is sometimes called the Mutankiang mountains, after its main river, the Mutankiang. The Liaotung mountains occupy a strip 600 kilometers long and 450 kilometers wide; their lower southwestern end penetrates into the Liaotung peninsula. The central and northeastern portions of the mountains have altitudes of 1,000-1,300 meters. A clearly east-north-east ("Liaotung") direction of

the ranges predominates, that responds to the directions of many ancient and latest tectonic lines. The Liaotung extension has a longitudinal Fushun-Hailun dale as well. Along with that, transversal ranges are quite widely encountered, which were principally formed by most recent faulting.

The peripheral portions of the Liaotung mountains are characterized by rounded, gentle outlines and low ridges. A terraced fringe provides a gentle transition to the plains and mountains. The monotony is in places broken by the basaltic covers, which create table-top types of relief. These sections are sharply contrasted with the ancient gneiss chains of Liaotung with homogenous, symmetrical ridges of equal height, sometimes intricately notched. The slopes are frequently craggy, the valleys represent chains of narrow points and wider areas containing lakes.

The relief that was formed from folded sedimentary deposits of various consistence (limestone, shale, arenaceous quartz) is more involved and variegated; the most varied forms are frequently found in the neighborhood, such as pointed peaks, cupolas, table-top mountains, extended cornices, areas of peacefully outlined knolls, etc.

Particularly grotesque cliffs adjoin the Yalu river valley -- "quartz reefs", moulded through erosion into columns, ruins and castles. In places where the sedimentary deposits are broken by the intrusion of granite-porphyry, saw edge shaped ridges are encountered.

The Liaotung mountains form the most treeless portion of the East Manchurian mountains. Good forests are preserved in the northeast and on the Lunkangshan and South Lieling ranges. The valleys are densely populated.

The South Manchurian industrial region adjoins Mukden and is based on the richest iron ore deposits of Anshan and Pensi, on the coal deposits of Fushun, Penchiand Yantai, and on a number of non-ferrous metal and polimetal deposits. Industry has developed extensively here, especially the metallurgical industry.

The Tungpiangtao industrial region, that is next to the middle course of the Yalu river and to the valley of its right tributary, the Hungtsian river, started to develop during the most recent years (from 1939); Japan advertised it as the "Manchurian Ruhr". The mining of iron ore and coking coal was started here before 1945. This is a splendid basis for the development of metallurgy. The largest cities are Tunhwa and Linkiang (Maoreshan).

The Liaotung peninsula (225 kilometers long, 80-180 kilometers wide) is outstanding in the peculiarities of its shoreline. The peninsula is built symmetrically. Its southeastern and northwestern shores are rectilinear, low and

contain sand bars, a wide strip of which is revealed at low tide and are inconvenient for navigation. At the same time, the southwestern end of the peninsula has a strongly cleft coastline, that is reminiscent of the shores in the Vladivostok region and contain convenient harbors.

The Kwantung bay, which is 35 kilometers long, divides its narrow, 27 kilometer wide portion, Kwantung peninsula [See Note<sup>7</sup>] from the rest of the Liaotung peninsula.

[Note<sup>7</sup>] "Kwantung" means "eastern gates", i.e. east of the seacoast portion of the Shanhaikwan in the Liao mountains. Kwantung is a name that is applied by the Chinese to all of the Liaotung peninsula.

Approximately in the middle the peninsula is divided by two more bays that are situated across from each other (Tsinchouwan and Talianwan) into two parts -- the northeastern mainland portion and the southwestern, peculiar portion that resembles the Port Arthur peninsula (45 kilometers long and 25 kilometers wide). Both parts are divided by the Tsinchou isthmus, which is only 3.5 kilometers wide. Among the numerous splendid bays, the most outstanding ones are the Port Arthur and the Talienshan bays with the excellent ports and cities that developed here -- Port Arthur and Dairen. The first competent study and description of the Kwantung peninsula was made by a Russian topographer, Samoylov, and a geographer, K.I. Bogdanovich (1900).

The surface of the Liaotung peninsula represents a low and treeless, hilly-dismembered flat land, which contains only a few rocky outcrops of the more steady types of rock. The Tageshanshan mountain on the Tsinchou isthmus and the Laoteshan mountain in the southern end of the Port Arthur peninsula are of that type.

Almost the entire territory is planted with Kaoliang and corn; uncultivated areas are covered by low grass grazing lands, that are green from May to September. During the remaining portion of the year the terrain appears lifeless. The thickets of underbrush are encountered only on some steep slopes and groves of aspens and pine trees are found by settlements and cemetaries. Alleys of trees containing birch and poplars extend along the rivers.

The Kwantung peninsula and the southwestern portion of the Liaotung mountains with the adjoining foothill plain were the scene of military actions during the Russo-Japanese war of 1904-1905. It was here on the "knolls of Manchuria" that the bloodiest battles for the Fengshuilun pass, Liatan and Mukden and the Tsinchou isthmus took place, as well as the 11 month long defense of Port Arthur.

During 1899-1905, the Kwantung region was leased from China by Russia, and later seized by Japan. After the defeat

of imperialist Japan by the USSR in 1945, this region was returned to China.

The northeastern half of the East Manchurian mountains (Mutankiang mountains) is filled with complex arrangements of the ranges between the Sungari and the Ussuri rivers. The principal portion of these mountains is composed of gneiss and granite. Extensive areas in the east are covered by basalt. Three main chains stand out in the structural relief, that diverge slightly towards the northeast with two strips of broad valleys and depressions between them. The mountain chains are usually wooded and the valleys and depressions are treeless, covered with meadows and are cultivated. Each chain consists of numerous separate ranges, that bear individual names. The western chain - Chankuantsailan - extends almost along the meridian. The Tatutsin (1,692 meters) towers in the highest portion of the chain on the wild and wooded Peitaiyan upland area. The northern tip of the chain forms the southern border of the Sungari corridor.

The axial chain, Central Liao-ling -- is the longest one (over 700 kilometers long) of the whole system. In the southwest it is a part of the Changpai Shan plateau, to the northeast of the Chinese Railway its principal watershed is called the Khentei-Alin, and still farther towards the northeast a still less known and wild chain of low mountains called Nadan-Hada-Alin stretches deep into the plain, towards the border of the USSR and forms the western edge of the Ussuri corridor.

The eastern chain of the Taipinglin, the northern portion of which passes along the USSR border and is called the Pogranichnaya, stretches along the meridian, but in the south the range becomes almost latitudinal and is called Nanganlin. Its lowered and treeless middle portion is dissected by a through valley of the Gayalhe river.

There is another short, low mountain chain to the east of the Taipinglin, called Chernyye mountains or Heishanling, that passes along the USSR border.

There are transversal bulkheads and broad basaltic plateaus between the enumerated mountain chains. These are regions containing especially wild forests. In addition to that, there are numerous spurs leading from the main chains, most of which form additional longitudinal elevated strips (the Western Laoyelin range, Hsiaogokushan, and many others).

The chains and their spurs are divided by a number of large valleys and depressions. The main valley is the valley of the Mutankiang river, that is the largest right tributary of the Sungari river, and is located between the eastern and the axial chains. The valley forms two wider areas -- the intermountain depression -- the upper one -- Tunghua (at an altitude of 450-550 meters) containing the cities of Emu and Tunghwa, and the lower one, the Ningutin (at an altitude of

approximately 350 meters), containing the cities of Ningan (Ningan) and Mutankiang (Ninbei). Between these depressions the valley is partitioned by the lava flow, that erupted from the Paitae'an uplands during the recent past (there are legends regarding this). The lava laid a foundation for a number of lakes in the main valley and in the valley of its tributaries, including the Tsinbohu lake, that is a remarkable feature of the Mutankiang valley. This lake is approximately 40 kilometers, the altitude at water level is 370 meters. It flooded the narrow portion of the valley and brought the Mutankiang tributaries into the valleys, as a result of which it has a grotesque heart-shaped appearance. It is up to 38 meters deep. The Mutankiang river which flows through the lake, passes through the basaltic barriers in a majestic waterfall 20 meters high. An hydroelectric power station with a capacity of 30,000 kilowatts is located here.

Among the other intermountain depressions of importance are the Lafakhe, Tsiangtao (Yangtze) and Huchun. The eastern and axial chains are split by a broad meadow valley of the Muleng river, or the Mulin river, along which a number of important bituminous coal deposits are located. There are no wide depressions along the Suifun (Suifenhe) river, that empties into the Sea of Japan; it abounds in difficult narrows.

From the west the described portion of the East Manchurian mountains is accompanied by a number of foothill rows of hills, that represent low mountain terrain. The largest area covered by this type of terrain approaching Harbin, is known as the Pinchou knolls.

#### The Changpai Shan Plateau.

The Changpai Shan or the Chenpeksan plateau ("Ever White Mountains") -- is a gigantic contour of basalts, unifying the North Korean mountains with the East Manchurian mountains. This is a most important orographical and hydrographical junction. The Paitou Shan volcano (Paitou Shan or "the White Top Mountain"), that is located there, is 2,744 meters high and is the most important summit in all of northeastern China and all of Korea. The mountain top is not called "white top" because of snow, which melts during the summer, but for the white color of the pumice stone, that forms the upper portion of the volcano's slopes. A very beautiful lake called Tianchi (chenchi) is located in the craggy crater; this lake is considered by the Chinese and the Koreans, as is the whole volcano, sacred ("home of the dragon"). N.G. Garin, who gave a colorful description of the volcano (1904), indicated that it continues to show signs of activity (explosions with an eruption

of gasses and rocks).

#### The North Korean Mountains.

The North Korean mountains are formed by the southeastern, tallest strip of the Manchurian-Korean mountains. It extends in the shape of a so-called Tungus arc, its convex portion facing to the southeast. It is 600 kilometers long, and 100-200 kilometers wide at the center, and 60-70 kilometers at the ends. The highest point is Kwanmobon (2,541 meters); many summits of the Tumen range are higher than 2,000 meters and bear traces of ancient glaciation; the predominant altitudes are 1,500-1,800 meters, low mountain areas are widespread in the northeast and the southwest.

On the whole the mountains represent a non-symmetrically raised fringe of the Asiatic continent, which ends precipitously in the direction of the sea in faulted slopes; towards the northwest it faces with a gently tilted and mildly dismembered ancient denuded surface -- the Kem uplands. The principal longitudinal watershed of the North Korean mountains, that separates the Yalu and Tumen river basins from the basins of the tributaries of the Sea of Japan, passes quite close to the sea coast.

It has for a long time been thought that this watershed coincides with a single Main or Stanovoi range of North Korea. Lubentsov distinguished two parts in it: the northeastern part -- the Tumen range, parallel to the upper and the middle courses of the Tumen river (Tum<sup>en</sup>gan river in Korean), and the southwestern part -- the Amnokkan range along the Yalu river (Amnokkan range in Korean). Recently it was revealed that in the place of this "Amnokkan range" there are four isolated coulisse chains, along which, passing from one to the other, lies the main watershed (Puchzhollen, Nannimsan, Tekyuren and Kalyuren). These chains are combined into the Amnoldam upland.

Along with the principal longitudinal watershed of great importance is the principal crosswise watershed between the Yalu and the Tumen river basins, that separates the Tumen mountains from the Kem upland. It passes along a mighty ancient volcanic range called Machholten, which is up to 2,435 meters tall. At the point of intersection of both these watersheds, i.e. at the meeting point between the Kem upland with the high mountain Tumen range, the high Hsiachangpai Shan (Lesser Changpai Shan) plateau is located; it is 10-20 kilometers by 50 kilometers, with flat platforms at altitudes of 1,700-2,000 meters. It is overgrown with a deciduous forest similar to the main Changpai Shan plateau.

The Kilchou-Menchhon ridge, with a low hilly relief, covered by carboniferous Tertiary and young volcanic rock, etched through erosion is located by the southwestern foothills of the Tumen range. It characterizes the Sanmebon or "Seven Treasures" coastal range, which is up to 1,193 meters tall; its wild craggy summits are composed of trachytes.

One more basin composed of Tertiary deposits adjoins the northeastern end of the Tumen mountains, it is the Hvern city region and the most important iron ore Musan basin. The valleys and plains close to the mouths of the Yalu and Tumen rivers are cultivated and densely populated; they are crossed by important means of communication.

The Ken upland (Kayma) is the highest and most massive portion of the North Korean mountains, and is up to 150 kilometers across; along with the Ch'ang i Chan plateau it forms the coldest and most severe region of Korea, "Korean Siberia", or "the roof of Korea". The upland is gently tilted towards the north and sharply cut off by faults to the south. The northern incline is slightly etched by the left tributaries of the Yalu river, the basis for the erosion activity of these tributaries is formed by 500-700 meter levels in the north. Most of the upland area has a socle of not below 1,000 meters. Meridional ranges 2,000-2,500 meters tall rise between the valleys of these tributaries. The relative altitudes of these ranges above the upland plateau are not very great, due to the fact that their relief has the aspect not of a high mountain terrain but that of one of average height.

The lack of symmetry in the construction of the upland area permitted a peculiar solution to the problem of obtaining hydro-electrical energy. The highwater rivers on the northern incline of the upland area are blocked with dykes in the middle parts of their current; this formed large reservoirs. Part of the hydro-electrical energy is generated on the spot by the hydro-electrical power stations located next to the dykes. A large portion of the water is, however, diverted from the reservoirs along tunnels and pipes to the opposite (southeastern) upland incline with its considerably greater degree of inclination and difference in altitudes. This permitted the construction of a number of hydro-electrical power stations here, that yield hundreds of thousands of kilowatts of energy and which supply important industrial regions of the north Chinese ports and Hamhyn.

Only small parts of the Kem upland area has been exploited, primarily the area around the electrical power stations, mining villages and along rivers. The upland area is covered with coniferous forests, a part of which was systematically burned on the more level plateaus, during domination by the Japanese, by the kademing -- landless Korean

immigrants from the peninsula, who then used that area for cultivation. The predominant crops on the Kem upland area are oats and potatoes.

The eastern coast of North Korea is mountainous and partially terraced, and extends in a comparatively straight line parallel to the young faulted edge of the North Korean mountains. The lowland areas are found only in the upper ends of the infrequent bays, river deltas, in particular in the Tumen river delta, and to both exits of the Kilchou-Menchhon dale. The most wild and precipitous shoreline is located by the slopes of the Sanmebon range.

The northeastern segment of the shoreline underwent submersion and bears the typical signs of an ingressive coastline; it is very similar to the shoreline in the Vladivostok region. Large ports are situated by the deep bays, Chongjin, Najin and Unggi. Chongjin (with a population of over 200,000) -- is a mighty industrial center, which forms a most important industrial North Korean portal region together with a number of cities that surround it.

Low terraces approach the western shore of North Korea; their sedimentary rock is covered by loess-like loam. The shores are touched by a shallow sea, that drains away over a wide strip during low tide. Extensive areas of these tidal lands have been reclaimed from the sea by means of dams and are occupied by salt fields and even rice fields. The border industrial area of Antung-Siniju is located at the mouth of the Yalu river. Yongampo serves as its main port.

#### THE KOREAN PENINSULA

The Korean peninsula is a remnant of an ancient presently destroyed dry land bridge between the mainland and the Japanese islands, which at one time served as a route for the continental flora and fauna that migrated to the middle links of the east Asiatic island chain.

Korea occupies an intermediary position between the continent and the islands, both in its geographical position and in its many landscape peculiarities; it contains a number of contrasting maritime and continental natural and economic features.

The peninsula juts abruptly for 600 kilometers in a direction away from the mainland between the Yellow Sea and the Sea of Japan and is separated from Japan by the Korea Strait.

The predominant width of the peninsula is 200 kilometers; it is 132 kilometers wide at its narrowest point in the north, the massive Korean isthmus.

Man's influence on the nature of the Korean peninsula was first of all reflected in the extensive destruction of the forests and in the prolonged and thorough cultivation of the fields. Rice crops are especially widespread; they cover 60%-80% of the sown area in the plains, primarily on watered land. Also widespread are fields of bean, millet, wheat, barley and yams in the south. The role of sericulture is also important.

A large number of mining enterprises are typical for the industry of the Korean peninsula -- mines, shafts, quarries. Centers of a mighty processing industry are the following industrial regions: the Pyongyang region which includes the cities of Pyongyang, Kyomipo and Nampkho; the Seoul industrial region with the cities of Inchon (Jinsen) and Seoul, the Hamhung industrial region with the cities of Hungnam and Wonsan, and the South Korean industrial region which includes the cities of Pusan, Chinhae and Masan.

A railroad crosses the entire length of the peninsula, Pusan-Seoul-Pyongyang-Antung; it leads from Korea into China. There is also a railroad that operates along a portion of the eastern coastline. Among the highways the most important ones are the Wonsan-Pyongyang and the Kangnung-Seoul highways.

In studying the nature of Korea, it is important to keep in mind that the division of Korea into a northern and a southern section along the 38th parallel is purely artificial from the physical-geographic standpoint. The northern part of Korea is, however, still quite different from the southern portion in its natural conditions and in its economic peculiarities. The most clearly differentiated border between these landscape regions is formed by the Korean isthmus (near  $39^{\circ}30'$  North Latitude), to the north of which is the mainland portion of Korea (part of the Manchurian-Korean mountains), and to the south the peninsula.

There is also a third method of dividing it into North and South Korea, which is adhered to by many writers beginning with B. Koto (1902), who draw the border between the two parts along the line Seoul-Wonsan, along the Chihukoren date. They therefore include not only mainland Korea into North Korea, but the northwestern portion of the peninsula as well, the so-called Old Korea. The basis for this is formed more by historical-political considerations, rather than by physical-geographical data.

Discrepancies between the cited divisions must be remembered when using geographical literature on Korea as various writers understand different territories under the same names.

### The Geological Structure.

The Korean peninsula is a great boulder placed at an angle, uplifted by the Upper Pliocene movements as a link in a unified Kyukyu-Korean or "peritungkhai" arc (surrounding Tunghai, i.e. the East China Sea). At the time when the southern segment of this arc (the Ryukyu islands) was raised along the axis of the East Asiatic geosyncline, the Korean peninsula became situated in an almost transversal direction with relation to it and to a large degree represents a fragment not of a geosynclinal, but of a platform structure. This is a part of the Chinese platform, where the Pre Cambrian Shantung-Korean shield becomes submerged under the scarcely affected Upper Proterozoic and Paleozoic sedimentary rock. This region underwent folding-boulder disturbances during the Mesozoic period and even stronger vertical displacements of great extent during the Tertiary and Quaternary period. Only the southern end of the peninsula consists of younger rocks and folded structures of the Yang Shan and Mao Shan age (Mesozoic-Upper Pliocene).

The Pre Cambrian period is represented on the peninsula primarily by gray gneiss that occurred as a result of the metamorphosis of granite, and a very thick metamorphic deposit of limestone and mica shale, resembling the Chinese Proterozoic period.

The Paleozoic period on the Korean peninsula is composed of deposits of the second Paleozoic and Cambrian periods, that consist of red shales and "great limestone", and the Permian-Carboniferous period is represented by shale, sandstone and limestone with numerous interlayers of anthracite. All of the marine Paleozoic layers were crushed into folds at the end of the Permian period, after which a prolonged period of accumulation of the continental Mosozoic deposits took place under geosynclinal conditions. These deposits consist of conglomerates, shales, sandstones, tuff, and flows of andesites and trachytes; they were slightly crushed at the end of the Mesozoic period and now form the southeastern portion of the Korean peninsula.

During the Cainozoic period the peninsula was split by faults and transformed into a complex mozaic of recently transposed boulders. Extensive basaltic effusions took place along a number of faults during the Quaternary period, which formed several upland plateaus. The Upper Pliocene Mao Shan movements completed the present structure of the southeastern portion of the peninsula.

Volcanic activity continued on the Cheju island during the 10th Century.

Korea is exceptionally rich in useful minerals. The Pyongyang Upper Paleozoic anthracite basin is outstanding among

the numerous deposits of pit and moor coal. Iron ore reserves of the "great limestone" Lower Paleozoic deposits are known, the most important of which is located in Kyomipo. Large gold deposits are found among the gray Pre-Cambrian gneiss.

Many deposits of non-ferrous, light and rare metals and polymetals, world supplies of graphite (in contact with granites), mica and many others are also known. A large industry, including the metallurgical industry, developed in Korea during the past several years based on the mining of these riches and the availability of cheap hydro-energy sources.

The relief of the Peninsula was created by a complex action of tectonic, structural, lithological and erosion factors on the initial Pre-Miocene levelled surface. This surface cut through all structures, independently of their age or extention-- platform structures, in the northern and central portion of the peninsula, with predominantly north-eastern (Upper Proterozoic) extensions of the ancient folds of the Shantung-Korean shield and granite intrusions, as well as the Mesozoic folded structures at the southern end of the peninsula, that have an almost latitudinal South Korean (Hansanskiy) extension.

Starting with the Miocene period, the initial surface underwent sharp vertical transpositions, and the peninsula which started to form was rising as a single large geosyncline, while in the Sea of Japan, next to it a geosynclinal descent of the sea bottom was taking place. Both transpositions had a non-symmetrical profile: the geosynclinal axis and the geosynclines became situated very close to each other, being divided by a steep common vane. This vane forms the presently existing steep eastern slope of the Korean peninsula and the slope of its underwater socle, which is almost as steep. The East Korean mountains adjoin the eastern coastline in a continuous line; their average altitudes are 1,000-1,300 meters and infrequently 1,500-1,700 meters, and the sea attains depths of over 2,000 meters at a distance of 10-15 meters from shore.

The western vane of the geosyncline of the Korean peninsula is distinguished by its extremely gentle slope. Tectonic lines along which the Korean peninsula rose during the Miocene period, on the whole had an extension that was close to meridional ("Korean"). Movements began along this extension during the Mesozoic period. They encompassed and disturbed the more ancient structures of both Upper Proterozoic and South Korean extensions. Therefore, structures having alien extensions are frequently encountered among the meridional folds and chains of the East Korean mountains.

The uplifting brought about a strong rejuvenation and dismemberment of the relief into numerous ranges of average

height.

The new levelling cycle to a new, lower basis extended over a very significant distance; especially along the entire western strip of the peninsula.

The latest uplifting brought about the dismemberment of this "fringe level area" into a number of low mountain chains (400-700 meters) and knolls (200-300 meters) in the western portions of Korea, as well as the evolution of a number of sea terraces along the eastern coastline of the peninsula. The altitude of the terraces is 20-150 meters. The western and eastern coastlines, on the contrary, became submerged; they were inundated by the sea, which resulted in a complex labyrinth of bays and straits, peninsulas and islands (there are about 3,500 of the latter).

As a result of these processes, the relief of the Korean peninsula appeared to have two stories. It is patterned from two rows of initial levelled surfaces, whose outlines may now be only mentally restored along the equally high ridges.

A very sharply dissected mountain relief with steep slopes formed on the peninsula as a result of the rejuvenation of both denudation steps. Some of the more stable deposits of ancient structures and intrusion nuclei remain. Therefore, ranges of several different extensions combine in a grotesque form in the present relief.

Breaks were conducive to the existence of additional stepped features of the relief. Basaltic lava, that was erupted along certain breaks, created several basaltic plateaus, that blocked the valleys. This brought about a number of changes in the configuration of the hydrographic network (perforation of the blocks and an epigenetic replacement of water flows in new directions). The plateaus are etched with canyons that are up to 100-200 meters in depth. The canyon walls frequently consist of compact rows of six sided columns, forming "Basaltic organs" (a columnar separation of the basalt). In places where these columns are cut off by the terrace platforms, they are seen in cross section and have the appearance of tiled mosaic ("roads of the giants").

With the small number and size of the intermountain depressions in Korea, basaltic plateaus are important as even spaces, rarely found in the mountains, that are convenient for cultivation.

The valleys that dissect the Korean peninsula usually have steep slopes, are frequently found along fault lines, have an unfinished longitudinal profile; the rivers that flow through them abound in rapids and waterfalls, frequently cut through the longitudinal ranges in narrow transversal gorges. The areas between ranges are occupied by spurs almost up to

the very thalwegs. Areas 3-5 kilometers wide are found in only a few longitudinal valley segments. The relief becomes a gentle slope only by the western shore, which adjoins comparatively broad (up to 20-30 kilometers across) hilly plains. Three layers of river terraces rest on the corresponding shore terraces.

The shores of the Korean peninsula bear the stamp of the history of its most recent tectonic development. The eastern shores differ considerably from the western and southern shores.

The eastern coastline, clipped by a great fault, is distinguished by its even shoreline. The uplifting was so young and intensive, that the present configuration of the coast does not depend almost at all on the various types of geological structures that it cuts through. The shore is mountainous, and is fringed only by a narrow strip of terraces; it is almost completely devoid of lowland plains. The Korean isthmus contains a perceptible plain, the Hamhung plain, which is an important industrial and agricultural region that includes the large cities of Hamhung, Hungnam and the port of Wonsan. There are almost no islands, the sea is deep along the shoreline, the height of the low and high tides does not exceed 1-2 meters.

The southern and western coastlines are typically ingressive; it is one of the most irregular coastlines in the world; it is marked by an innumerable number of islands of the South Korean and Western Korean Archipelago. Individual mountainous capes and peninsulas (flooded ranges) are separated by areas of lowland shores that adjoin the upper reaches of complex bays (flooded valleys).

The sea is distinguished by its shallowness along the western coastline (less than 10 meters), a great difference between the high and low tides, which increases from south to north from 3 meters to 9 meters in the Inchon region and decreases to 6 meters towards the northwest. Strong tidal currents occur in the narrow bays and straits with speeds of up to 15-18 kilometers per hour. The combination of shallow waters with extensive low tides leads to a situation where many bays dry out completely at low tide, and sometimes the entire strip along the shoreline dries out to a width of 5-10 kilometers. A sand or liquid silt ground, that is partially overgrown with reeds, is revealed at low tide. These "land-like" formations are very difficult to represent on maps.

The western shore is most inconvenient for navigation, despite the abundance of bays and gulfs. The ports of Mokpo, Kunsan, Inchon, the exit port of Seoul, and Nampho, the exit port of the Pyongyang industrial region, are the only ports suitable for use by sea-going vessels. The southern shoreline

is just as irregular, but has deeper water along the coastline, has a smaller difference between its high and low tides (2-3 meters) and abounds with the best harbors in Korea -- Pusan, Chinhae, Masan and Yosu.

The climate of the Korean peninsula is clearly of the monsoon type; the winter and summer winds blow in almost directly opposite directions. The winter monsoon blows from the north and northwest, it is complicated by the presence of a local "center of activity" of the atmosphere over the interior parts of the country, that forms local monsoons which are perpendicular to the shoreline. The wind direction along the course of these monsoons changes depending upon the configuration of the shoreline. The southwestern end of the peninsula is distinguished by higher humidity, since the winter monsoon reaches it after passing over the waters of the Yellow Sea.

Despite the fact that the peninsula protrudes abruptly into the sea, its climate is extremely continental: the summers are warm, hot in the southern portion, the winters are cold. Both the heat and cold attain greater extremes than could be supposed for the Korean latitudes. This is associated with the fact that the climate of the peninsula is basically moulded by an intrusion of powerful extraneous air masses -- cold winter masses from the northwest and moist and warm summer air masses from the southeast, and to a much smaller degree to their transformation locally.

Typhoons of gale force are frequent along the coastal areas, especially during autumn. Strong foehns are very common for the east coast (especially in the Wonsan region). The temperature conditions are evident from the following table:

Average temperature by months							
Meteoro-logical station	Altitude in meters	I	II	III	IV	V	VI
Cheju....	24	4.7	4.3	7.3	12.3	16.2	20.2
Pusan....	15	2.1	2.9	7.0	12.3	16.3	19.9
Seoul....	30	-4.6	-2.0	3.2	10.7	16.1	21.2
Wonsan...	36	-3.5	-2.5	2.4	9.4	14.6	19.2
<hr/>							
		VII	VIII	IX	X	XI	XII
							Aver-age Annual
Cheju....	25.3	26.0	21.9	16.5	11.9	7.4	14.5
Pusan....	23.8	25.6	21.8	16.3	10.1	4.1	13.5
Seoul....	24.6	25.5	20.0	13.1	5.1	-2.1	10.9
Wonsan...	22.8	23.4	18.8	13.1	5.6	-1.1	10.2

The coldest month is January, the warmest month is August. Average monthly temperatures above zero during January are a feature of the southern end of Korea only, which is warmed, in addition to the more southerly sun, by the constant warm current (Tsushima branch of the Kuro-Sivo).

During the winter the east coast is warmer than the west, despite the presence of a cold current, apparently due to the protective nature of the ranges and the warming effect of the foehn; during the summer the west coast becomes warmer due to the penetration of the seasonally active branch of the Kuro-Sivo into the shallow Yellow Sea. The Sea of Japan, which is deeper, becomes warmer at an incomparably slower rate and to a lesser degree.

The level of precipitation on the peninsula is 1,000 millimeters, and attains 1,400 millimeters in Pusan. The heaviest rains occur during the summer monsoon, partially

during the period of "plum rains" (July). Seoul received 355 millimeters of rain in the course of a single day in August of 1920. The snow does not remain on the ground very long, except in the mountains.

Annual Rainfall  
(millimeters)

Meteoro-logical station	Months						
	I	II	III	IV	V	VI	
Cheju .....	55	59	50	83	68	151	
Pusan .....	52	39	62	146	122	198	
Seoul .....	30	22	38	75	82	129	
Wonsan .....	37	34	45	70	86	123	
Pyongyang .....	17	12	25	44	66	67	
<hr/>							
	VII	VIII	IX	X	XI	XII	XIII
Cheju .....	213	228	276	45	57	92	1,377
Pusan .....	304	182	169	68	45	29	1,416
Seoul .....	376	268	119	40	45	26	1,250
Wonsan .....	269	314	181	82	71	30	1,362
Pyongyang .....	259	203	125	20	39	20	922

The rivers of the Korean peninsula are numerous and full. The longest and calmest rivers are found on the western incline, whereas the Sea of Japan receives tumultuous mountain streams. The southern incline contains only one large river -- the Nakdong river.

The types of relief and the abundance of water are conducive to the utilization of the rivers for the generation of

electrical energy and for irrigation. Large dams were built on many rivers and big water distribution basins-reservoirs were formed.

The regime of the rivers is most unstable. Prior to the summer rains the small rivers dry out almost completely. The summer rains frequently cause turbulent floods. The tidal wave affects rivers on the western incline for a considerable distance inland. The large rivers are navigable at their lower courses. The Taedong river, which is 439 kilometers long is navigable over 260 kilometers of its total length; the Han river, which is 514 kilometers long is navigable over 330 kilometers of its total length (Seoul is situated on it); the Kum river, 401 kilometers long is navigable over 130 kilometers; the Nakdong river, which is approximately 500 kilometers is navigable over 300 kilometers of its total length.

The Korean soils are predominantly scree brown soils, mountain podzol soils are encountered less frequently. Considerable water erosion combined with the extensive woodless areas bring about the existence of a thin layer of soil over much of the territory as well as an abundance of barren craggy areas and accumulations of scree. The plains abound with well sorted soils that are subjected to thorough cultivation and are artificially turned into marshes as the rice fields are flooded. Traces of red soil formations appear in the extreme south.

The vegetation of the Korean peninsula is transitory between that of Japan and the vegetation of Northeastern China, even though Japanese flora elements are predominant in the south. For hundreds of years the broad leaved forests which covered Korea even during the time of recorded history were felled in a most predatory manner, as a result of which a portion of the territory of the peninsula became treeless. During the last several decades artificial reforestation has intensified, however it only to a small degree replenished the forests that were continually destroyed by the Japanese, particularly during the Second World War.

The southern portions of the peninsula contain many varieties of evergreen vegetation; there is an abundance of oak trees and camellia among the chestnuts, that are green during the summer. Varnish and paper trees are cultivated; the paper tree yields durable paper, which is used for the manufacture of clothing, string, umbrellas and even floor tiles. The predominant type of initial vegetation through the remainder of the peninsula were broad-leaved forests. In regions where the forests were destroyed, trees were preserved only in the vicinity of cemeteries, monasteries and on inaccessible steep slopes. These are usually clumps of oak trees, groups of umbrella-like pinetrees, and juniper shrubs.

Specially protected pinetree and maple forests have been preserved in spots.

The majority of the mountains on the peninsula are not tall enough to reach the tree line level. The deciduous forests are gradually replaced with coniferous trees above 900-1,000 meters, and partially with the Korean cedar.

The southern and northern varieties of animals are intermixed in a grotesque manner in Korea. The Korean peninsula represents a special fauna province which is part of the Himalayan-Chinese zoogeographical Paleoarctic subregion.

The giant Korean tiger was encountered in recent times (a variety of the Ussuri tiger), and the East Asiatic leopard has been preserved; a single variety of marmosets, some species of deer (small hornless water deer, musk deer, Siberian stag, the punctate deer is almost extinct), and the brown and black Himalayan bear. A special local variety of the pheasant is found here. The small Korean horse, known for its stamina, is encountered, as well as bulls that are used as draft animals, and are known for their speed and agility that surpasses even that of horses in crossing over difficult mountain passes.

#### Landscape Regions of the Korean Peninsula.

The interior landscape differences on the Korean peninsula are provided first of all by variations in the latitudinal position and geological structure in the north and the south, and in the second place by the differences in the southern and eastern landscapes.

The northern and middle portions of the peninsula are constructed of platform structures (little disturbed Paleozoic structures on a folded granite-gneiss foundation) and have a moderate climate. The southeastern portion of the peninsula is constructed of folded Mesozoic structures; the climate here is moderate to warm and becomes subtropical (winter fields yield a harvest of barley).

The eastern portion of the peninsula is covered by less densely populated mountains of average height, with a single more populated strip in the middle of the broad valley of the Nakdong river. The western portion of the peninsula with its shallow water coastline, hill-plain and low mountain relief, is more densely populated and cultivated. The most important roads and railways pass through here and the large industrial centers of the country are located here -- Seoul and Pyongyang.

It was pointed out in 1902 that Korea has no main or "a backbone" range and that a lowland strip extends through the length of the peninsula from Seoul and Wonsan -- a tectonic depression of the Chkhukoren (Tungarion) dales. This strip

divides the peninsula as if along a diagonal line and separates the East Korean mountains in the eastern portion of the peninsula from the Puktebon mountains in its northern portion. These two mountain systems end parallel to each other.

In the northern part the dale is covered with basalt, which formed the Chkheluon plain or the "Iron Plain". The Chkhukoren pass is situated on this plateau at an altitude of only 500 meters on the most important Trans-Korean railroad Seoul-Wonsan.

The East Korean mountains, frequently referred to as the Main range of Korea, extend along the eastern shore for 500 kilometers. In the north they form a strip 70-100 kilometers wide; in the southern half (south of the "holy" T'aebaek San mountain, 1,549 meters in height), this strip divides into two branches that fringe the only broad valley on the peninsula (Naktong river). In the south the extreme end spurs of both branches spread apart to a distance of 200 kilometers.

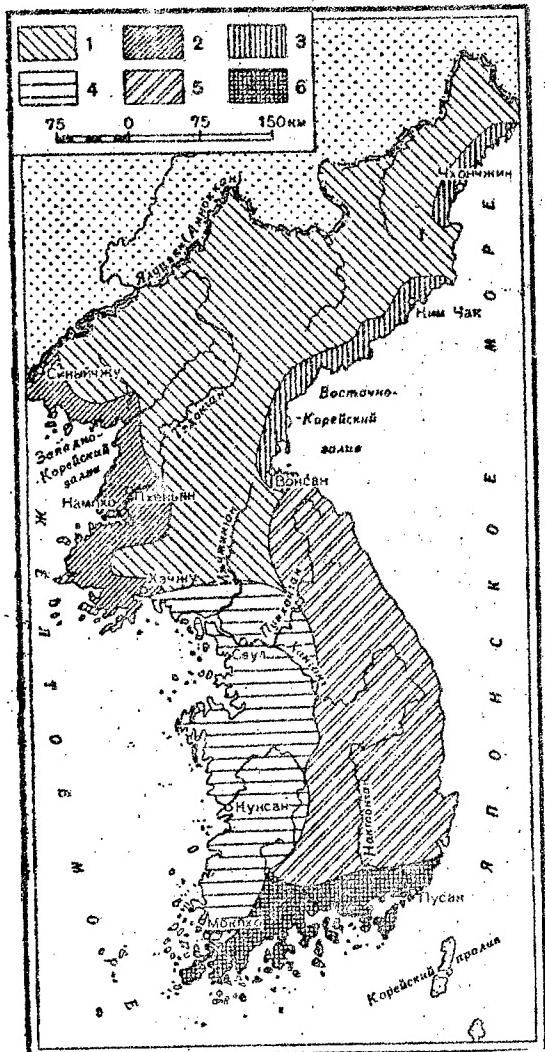
Three separate sectors are differentiated in the East Korean mountains: the northern sector, consisting of the Kungang San or Diamond, mountains, the middle sector, consisting of T'acbaek San or Big White Mountains, and the southern sector which includes the Kesan mountain. The great southwestern branch of the East Korean mountains is called Sotaek San or the Lesser White Mountains.

In each of these sectors the East Korean mountains represent a group of parallel chains, including not less than three such chains, which are individually not over 100 kilometers in length. As one range ends, another range starts at that point or another range branches out into two. The main watershed constantly shifts from one chain to another.

All these ranges are sometimes unified into three chains -- the western, axial and maritime chains. The eastern and axial chains have steeper eastern slopes, and the western chain has steeper western slopes. The main watershed more frequently coincides with the eastern and the axial chains and only in the north shifts to the tip of the western chain, as the tips of the more easterly chains are clipped off by the diagonal sector of the coast.

The highest point of the Big White Mountains is the Sorak San mountain in the Snow Mountains range and is 1,708 meters tall. The "White" and "Snowy" names are attributed to these mountains only because the snow remains on them for a long period of time, but of course disappears completely by autumn. An important Trans-Korean highway passes across the Tekallen pass at an altitude of 865 meters, from Seoul to Kangnung.

The Kungang ~~or~~ the Diamond mountains are the northern fragment of the East Korean mountains, the most reknown



Geographical regions of  
Korea (According to V. T.  
Zaychikov)

Legend: 1. North Korean mts.;  
2. Northwest Coast; 3. North-  
east Coast; 4. Western plain;  
5. East Korean mts.; 6. South  
coast and islands.

mountainous portion of Korea, where some of the most rare and beautiful scenes of nature and national monuments are encountered. This is the most peculiar region of the country, it is distinguished by its irregular nature, steepness and rockiness. The ranges of average height (1,600 - 1,400 meters) are here etched by such a dense network of steep gorges that a whole region is covered by most irregular ridges that are as sharp as blades, and earned the name of "country of 12 thousand peaks" from the Koreans. Gently rounded ridges are also seen, which have not yet been reached by the latest cycle of erosion. Hundreds of waterfalls roar at the bottom of the gorges, the steep slopes are covered with oak, fir and pine tree forests that have survived here. Tourist hotels, colorful buddist temples and tungsten mines are seen on the terrace platforms. The highest point in the Diamond Mountains is the Birebon mountain (Pirunbon), which is 1,683 meters

tall, and the best known summit, called Kymsangan, is only 1,113 meters high.

The Soeak San or "Lesser White Mountains" -- form the greatest southwestern branch of the East Korean mountains and form a chain 300 miles long; it has an Upper Proterozoic extension (south-south-west by north-north-east). The mountains form an important landscape border dividing the almost subtropical regions of the Naktong river valley from the west coast region with its more northern national condition and agriculture. The mountains consist of parallel chains of average height, that become lower in the central part and almost descend to the ground level at the Chkhutoren pass, which is located at an altitude of only 200 meters, where an important railway trunk line passes from Seoul to Pusan.

The southern end of the Soeak San mountains are adjoined by ranges that have a south Korean (longitudinal) extension, and in particular by the highest range on the Korean peninsula -- the Chiisan range, which is composed of granite and is 1,915 meters tall. The eastern links of these intermittent chains are barred on the south by the exit from the depressions of the Naktong river valley, which causes a large bend in the lower course of this river.

On the west the Soeak San mtns. are accompanied by two frontal granite chains of Upper Proterozoic extension -- by the more southern short Noren chain and the more northern long Chkhyorleng chain.

Both chains are intermittent and contain low mountains. Average altitude is attained only by separate summits.

The Puktebon mountains or the Large Northern Mountains, form the northern link of the peninsula's mountain chains, which is situated northwest of the Chkhutoren dale.

watershed of the Korean isthmus passes along these mountains. These mountains form a peculiar type of tectonic bridge between the peninsular and mainland portions of Korea and may be regarded as one of the spurs of the North Korean mountains. They consist of a complex system of parallel mountains of average height; the highest summit, which is called like many others, Paektusan (White Mountain), is 1,837 meters tall; the predominating altitudes are from 1,000 to 1,600 meters. The Takhobiren pass is located on the most important Trans-Korean highway from Wonsan to Pyongyang and is located at an altitude of 950 meters.

The low mountain region of western Korea, which is situated west of the Puktebon, Soeak San mountains and the Chkhyorleng chain, represents a complex diversified low mountain and hilly country with numerous chains of mountains extending in a number of different directions, with a tangled labyrinth of valleys (including many through valleys that facilitate

passage). There is also a large number of convenient passes, and the largest plains found in Korea. A crust with typical cones, blind valleys, caves and so on is found in the Paleozoic limestone in the northwest. All of the western part of Korea is very poor in forests. The valleys are cultivated for planting with rice, both dry and wet.

The Cheju island (Chedzyu, Kvel'part) rises in the western portion of the Korean Strait; it is 60 kilometers long and 13 kilometers wide. The island's mountainous relief is created through the accumulations of lava, surmounted by a number of volcanic cones. The volcanoes were active during the 10th Century. The tallest volcano is called Hannesan (Handasan); it contains a crater lake and is 1,950 meters tall. The island is densely forested. Its flora is associated both with the Korean and Japanese flora, leading to a supposition that the island is a remnant of a former dry land bridge connecting Japan with Korea. There are signs that permit an assertion that the island separated from Japan before it separated from Korea, as a number of northern plants, common to Sakhalin and Kamchatka, could have penetrated into Cheju during the cold time not before the end of the Tertiary period.

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